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# THESIS

ANALYSIS OF UNITED STATES' BROADBAND POLICY

by

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March 2007

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Broadband Internet access has become an important service that affects the economic and social makeup of a country. Broadband penetration is becoming extremely important as globalization starts to interweave the economies and policies of nations around the world. With every month that passes, the United States fails to close the gap in the digital divide both inside its borders as well as among the other countries that lead the world in broadband penetration. The lack of strong market competition among broadband providers and failing governmental policies is partly to blame. A brief overview of broadband technologies as well as an analysis of the United States' broadband market is undertaken and compared with some other countries in order to establish a baseline comparison. The United States has long been known as a leading innovator in technology and services. However, the lack of competition to bring higher speeds, lower costs, and universal access has pushed the United States out of the top ten world-wide in broadband Internet penetration. This Thesis explores how the United States could close the digital divide and become a world leader in broadband penetration and innovation.

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**ANALYSIS OF UNITED STATES' BROADBAND POLICY**

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requirements for the degree of

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# ABSTRACT

Broadband Internet access has become an important service that affects the economic and social makeup of a country. Broadband penetration is becoming extremely important as globalization starts to interweave the economies and policies of nations around the world. With every month that passes, the United States fails to close the gap in the digital divide both inside its borders as well as among the other countries that lead the world in broadband penetration. The lack of strong market competition among broadband providers and failing governmental policies is partly to blame. A brief overview of broadband technologies as well as an analysis of the United States' broadband market is undertaken and compared with some other countries in order to establish a baseline comparison. The United States has long been known as a leading innovator in technology and services. However, the lack of competition to bring higher speeds, lower costs, and universal access has pushed the United States out of the top ten world-wide in broadband Internet penetration. This Thesis explores how the United States could close the digital divide and become a world leader in broadband penetration and innovation

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# LIST OF ABBREVIATIONS

1. ARCEP
   Autorite de Regulation des Communications Electroniques et des Postes
2. ARPANET
   Advanced Research Projects Agency Network
3. BPL
   Broadband over Power Lines
4. bps
   bits per second
5. CATV
   Community Antenna Television
6. CLEC
   Competitive Local Exchange Carrier
7. DMT
   Discreet multi-tone
8. DSL
   Digital Subscriber Line
9. DSLAM
   DSL Access Multiplexer
10. European Competitive Telecommunications Association
    ECTA
11. EV-DO
    Evolution-Data Optimized
12. FTTC
    Fiber to the Curb
13. FTTH
    Fiber to the Home
14. FTTN
    Fiber to the Node
15. GAO
    Government Accountability Office
16. GDP
    Gross Domestic Product
17. IEEE
    Institute of Electrical and Electronics Engineers
18. ILEC
    Incumbent Local Exchange Carrier
19. IMF
    International Monetary Fund
20. ISP
    Internet Service Provider
21. ITU
    International Telecommunication Union

22. Kbps
    Kilo bits per second
23. LLU
    Local Loop Unbundling
24. MAN
    Metropolitan Area Network
25. Mbps
    Mega bits per second
26. Modem
    Short for Modulate Demodulate
27. NIX
    National Internet Exchanges
28. OECD
    Organization for Economic Co-operation and Development
29. P2P
    Peer-to-Peer
30. PITAC
    President's Information Technology Advisory Committee
31. POTS
    Plain Old Telephone Service
32. PSTN
    Public Switched Telephone Network
33. QOS
    Quality of Service
34. R&D
    Research and Development
35. Tbps
    Terabit per second
36. TCP/IP
    Transmission Control Protocol - Internet protocol
37. TOP
    Technologies Opportunity Program
38. UTP
    Unshielded Twisted Pair
39. VoIP
    Voice over Internet Protocol
40. WiMAX
    Worldwide Interoperability for Microwave Access
41. WWW
    World Wide Web

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# I. INTRODUCTION

## A. PURPOSE

The purpose of this thesis is to analyze policy decisions that have led to the broadband distribution problem in the United States. The United States will be compared to other countries in an attempt to determine what factors have made the United States' broadband distribution lag behind other industrialized countries of the world. Recommendations for new broadband policy for the United States will be offered in order to restore the United States' ranking as one of the top nations in the world in broadband distribution and quality.

## B. ORGANIZATION

This paper will be divided up into six chapters. The first chapter provides an introduction to broadband Internet access and also includes a brief history of telecommunications. The second chapter covers broadband technology and explains the differences and similarities between competing technologies. The third chapter gives an in-depth overview of broadband Internet access in the United States to include where broadband is available, the speed of various broadband access options, costs of broadband access and the policy issues in the United States affecting broadband distribution. Chapter IV contains an overview of various countries' broadband Internet access distribution and technology. Chapter V contains that could be made in the United States in order to enhance its broadband Internet access distribution as well as the speed and cost of the services. The thesis concludes with suggestions for further research.

## C. BROADBAND DEFINED

Broadband Internet access is commonly known throughout the world as "high-speed" Internet access which is "always-on." In the United States, broadband Internet access has been officially defined by the Federal Communication Commission (FCC). According to the FCC's website, the term "broadband" refers to advanced communications systems capable of providing high-speed transmission of services such as data, voice, and video over the Internet and other networks. For statistical purposes,

the FCC defines broadband Internet service as having data transmission speeds exceeding 200 kilobits per second (Kbps) in at least one direction: downstream (from the Internet to the computer) or upstream (from your computer to the Internet). Advanced broadband service is defined as having at least 200 Kbps in both directions. Although this definition helps with tracking broadband Internet access, compared to other countries' minimum broadband definition, the FCC's definition is considered too low by many scholars and it is many years past its relevance.

According to section 706 of the 1996 Telecommunications Act, the FCC was directed by Congress to "encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans."[1] It has been a goal of the FCC since the passage of the Act to broaden the deployment of broadband technologies. The FCC established the standard of 200 Kbps for broadband service as a way of being able to measure the progress of broadband distribution.

On March 24, 2004, President George W. Bush said, "This country needs a national goal for…the spread of broadband technology. We ought to have…universal, affordable access for broadband technology by the year 2007, and then we ought to make sure as soon as possible thereafter, consumers have got plenty of choices when it comes to [their] broadband carrier."[2] 200 Kbps may allow the FCC to report adequate broadband coverage and improving speed for broadband, however, the reality of the situation indicates otherwise. In comparison, the International Telecommunication Union (ITU) considers a transmission speed of 1.5 to 2 Mbps as being broadband. The Organization for Economic Co-operation and Development is the main organization that tracks broadband service throughout the world including the United States. Its minimum limit on what is categorized as broadband is 256 Kbps. The difference in broadband definitions has spurred other countries to advance their broadband networks while the United States' broadband network lags exceedingly behind.

[1] FCC Broadband. www.fcc.gov/broadband accessed January 26, 2007.

[2] The White House, April 2004.

### 1. Speed Requirements

Any speed that falls below the FCC definition for broadband is considered narrowband. 200 Kbps was considered fast in 2002-2003, but any Internet access that falls below this speed is too slow for many of today's data multi-media intensive online applications. As of 2005, 30% of American households still accessed the Internet through a dial-up modem rated at 56 Kbps.[3] Computer and Internet companies are now gradually phasing out dial-up modem services.

Beginning in the early 1990s, commercial ISPs exclusively offered Internet service to the home over copper telephone lines with the use of a dial-up modem. The World-Wide-Web (WWW) was just starting to become popular so its contents were rather simple and text-based instead of the media-based (videos and pictures) WWW of today. Those simple websites did not bog down the Internet much because of the small amount of data contained in them. This also meant the dial-up modem speeds did not have to be particularly fast in order to access those websites.

Running over copper wire, dial-up narrowband Internet access is slow compared with the minimum speed the FCC uses in its definition of broadband access. For example, using a 56K modem connection to download a 10-minute video or a large software file can be a lengthy and frustrating exercise. By using a broadband high-speed Internet connection, with data transmission rates multiple times faster than a 56K modem, users can view video or download software and other data-intensive files in a matter of seconds instead of minutes. The advantage of narrowband connections, however, is their availability. As long as there is an analog phone line present, access to the Internet is available through a dial-up modem.

[3] GAO, "Broadband Deployment Is Extensive throughout the United States, but It Is Difficult to Assess the Extent of Deployment Gaps in Rural area." p. 3.

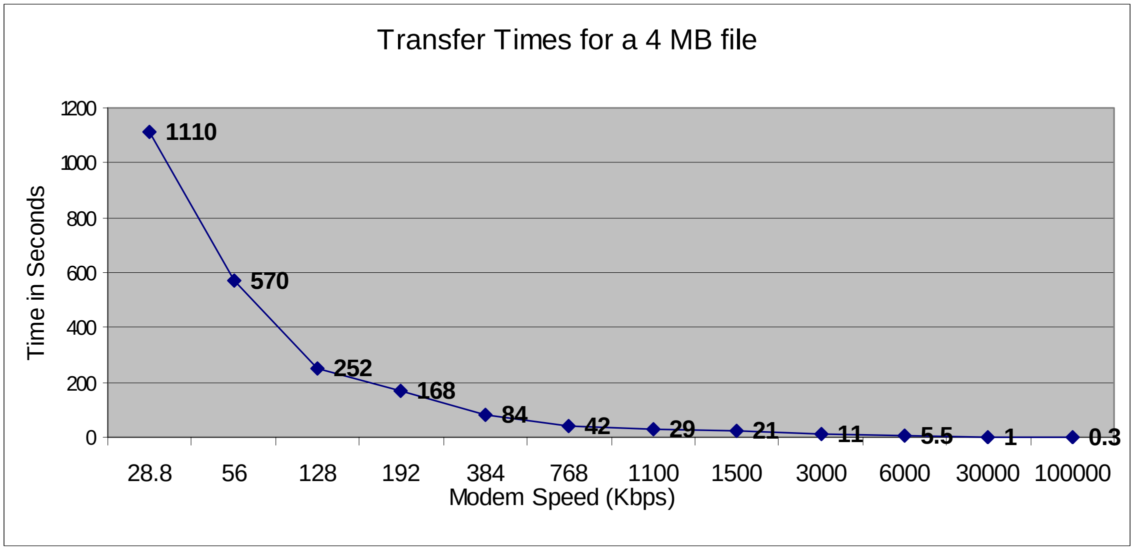


Table 1. Theoretical transfer times for a four MB file (times are approximate and may vary depending on network congestion).

Websites have changed dramatically since the turn of the century. New programming techniques combined with the distribution of personal computers around the world have increased the desire and requirements for interactive websites containing streaming video, graphic-intensive advertisements, and audio. The interactive applications often equate to high volumes of data flowing across the Internet. Internet users require more access speed for the video-intensive and picture-laden websites now common on the WWW.

The Internet enables users to exchange files electronically and interact with other users anywhere in the world. File sharing and interactive applications, such as on-line video gaming or video-teleconferencing, typically requires a broadband Internet connection in order to maintain an acceptable level of quality of service. A broadband connection's "always-on" feature allows for instant access to the Internet.

### 2. Applications

Just over twenty years ago, only eight percent of U.S. households had a computer, but by 2003, 61.8 percent had one.[4] The increase in computer ownership has also meant that many different applications have been created for computers that are useful tools for

[4] Crandall, p. 110.

the people using the computers. Broadband Internet access is used for many varieties of helpful, entertaining, and necessary applications. The Internet's value has risen dramatically since its development. The increasing importance and usage of Internet based applications have made broadband access a political and social issue affecting many communities throughout the United States.

### *a. Internet Browsing*

Web browsing may be one of the most common applications thought of when the word "Internet" is mentioned. The WWW was created around 1990 by Tim Berners-Lee and Robert Cailliau. The WWW contains Web pages that can contain text, images, and other multimedia such as video and audio. From 1995 to 1999, the number of websites on the WWW increased at a steady and linear rate; however, from 2000 to 2006, the number of websites on the WWW increased even faster as seen on the graph below.

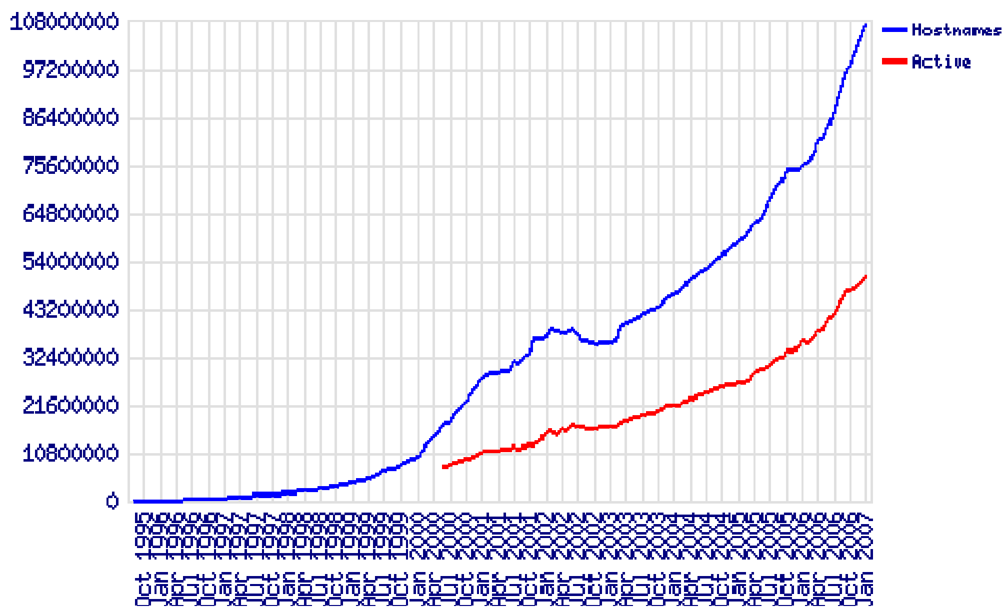


Figure 1. Number of Unique Websites 1995-2007 (From www.news.netcraft.com).

A January 2007 survey completed by NetCraft, a research company that deals with Internet-related statistics, received 106,875,138 responses from individual

websites. This immense number of sites is due in part to the ubiquity of the Internet. The sheer size of the Internet gives people even more opportunities to browse through various sites on the WWW continuously without running out of choices. Also, the data size of the homepages of these sites are growing exceedingly large, in turn requiring a faster broadband connection to view the site properly.

### *b. Email*

Along with web browsing, email may share the top spot with Internet browsing as one of the most common uses of the Internet. In terms of communicative methods between users, email is second only to the telephone as a mode of communication. In its Q1 2006 market update, The Radicati Group, a market research company, estimated the total worldwide email traffic per day at about 171 billion messages, of which 71 percent are spam. As of the end of 2005, worldwide email traffic per day was about 135 billion messages, of which 67 percent were spam. This is a 36 billion increase of email from the year before which is staggering. Email tends not to be as data intensive as Web browsing, but the estimated volume of emails being created every day often requires broadband access in order to download and view them quickly. Attaching large files (e.g., MPEG movies and PDF documents) to emails is common now.

### *c. Video Streaming*

The new phenomenon of video websites such as YouTube, Yahoo Video, Break, and Atom Films are becoming popular all across the Internet. To view videos over the Internet, a broadband connection is often necessary in order to quicken the download of the video or produce a smooth viewing rate while the video is streamed to the user via the Internet. The popularity of these websites has produced large streams of data on the Internet which take a broadband connection to view properly. Larger and larger videos are now making their way onto the Internet for viewing or downloading by all users which has increased the demand for even faster broadband access.

Although video streaming is mostly made up of online video viewing, some of the traffic comes from video teleconferencing and the use of webcams. Today there is a much greater chance that someone working in the corporate sector is working or keeping up to date with their office through the use of video teleconferencing. With globalization taking hold of the world, many companies are no longer only domestically based, rather, large companies are becoming international with offices and factories spread out around the world. The most cost effective way of communicating with all key players in the company around the world is through video teleconferencing.

Employees of these international companies are using video teleconferencing often to save on the costs of business travel or in order to make decisions faster by having impromptu virtual meetings. This type of communication has necessitated the requirement for broadband access not only to the corporate headquarters, but also to the private residences of the executives and employees who want to interact with each other while away from the office.

Video teleconferencing is not only left to the executives of the international companies. Military and private citizens also make heavy use of this technology. Private one-on-one conversations can be held with the use of a web cam and some sort of video teleconferencing application (e.g., Skype Video or SightSpeed). This is being used more regularity as broadband access and distribution becomes more common around the world. Broadband Internet access has given ordinary people with a computer and an inexpensive microphone and web camera the opportunity to talk and view someone else in near real time.

The United States' military routinely uses video teleconferencing to hold meetings with contractors, between leadership and to brief current situations with people stationed all over the world. It has quickened the response time and decision-making process which in turn can be instrumental in homeland defense and security.

#### *d. Voice over IP (VoIP)*

Traditional telephone lines have been in operation for over 100 years. When using those lines, there is a distinct path setup through the telecommunication's

network that cannot be used by anything else even when no data (voice signals) are being passed. This separate path that is setup provides a high quality of assurance for the particular voice signal, however, it makes the traditional telephone network very inefficient for carrying data. To make use of the underutilized telephone network, a new technique that was based on the packet switching advantages of the Internet was developed. VoIP utilizes the advantages of packet switching and applies it to analog telephone communication. Instead of setting up an individual path that is strictly tied up during a phone conversation, VoIP uses the packet switching protocols that break up the conversation into small data packets that travel on the Internet and then are pieced back together for the listener on the other end of the conversation. This allows for simultaneous use of the network by other protocols and applications.

The long distance phone charges have decreased a lot since the introduction of VoIP. VoIP is less expensive for companies to set up service for customers since the infrastructure the Internet runs on is the same for VoIP. All that is required is an Internet connection, and having broadband access increases the quality of service.

#### *e. Peer-to-Peer File Sharing*

Peer-to-Peer (P2P) file sharing is a way to share files between many hosts through the use of the Internet. With high speed access on college campuses, students used the campus-wide networks to transfer and trade files from computer to computer. The files often were text documents, but soon images, audio, and video files were being transferred as well. The advantages of sending documents via the network were dramatic, and the fast network connections which students had at the universities and colleges made it easy and quick. The convenience and speed in which the files could be transferred only heightened the requirements for faster networks and quicker access to the Internet.

Peer-to-peer (P2P) technology first became popular when Shawn Fanning and Sean Parker released Napster on June 1, 1999.[5] Napster became an instant success with Internet users which opened the door to a number of other successful P2P networks

[5] Wikipedia: Napster. www.en.wikipedia.org/wiki/Napster accessed January 28, 2007.

such as Kazaa and LimeWire which are still popular today. Today, CacheLogic, a firm based in England that monitors global peer-to-peer traffic, estimates that P2P applications consume between 60 percent and 80 percent of capacity on consumer ISP networks.[6] The popularity of P2P networks has meant that more Internet users are connecting to the Internet using broadband access rather than narrowband access.

#### *f. Software Distribution*

Software distribution has been made easy and nearly automatic with Internet access. Software companies (e.g., Microsoft, Symantec and Adobe) often have patches or updates that need to be added to their software being used on millions of computers connected to the Internet. To reach all of its customers, these vendors will include special applications that get installed on the computers or networks which automates the sending and receiving of important software updates over the Internet. Without the Internet, the process of updating new software would be expensive and time consuming.

## D. BROADBAND IMPACT

The Internet has transformed the world profoundly since its inception. Broadband technology has further enhanced the world's dependence on the Internet. Broadband access is not just a faster and more convenient way to view Web pages and download songs or videos. Many applications in use now, such as videoconferencing, VoIP, and video-on-demand, and many more which are still over the horizon, are dependent on broadband access. Broadband distribution has now become a political and social issue affecting the national security and economic stability of the United States. Kevin Martin, the Chairman of the FCC, recognizes that broadband technology is a key driver of economic growth. The ability to share large amounts of information at ever-greater speeds can increase productivity, facilitate commerce, and drive innovation.[7]

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[6] "P2P Fuels Global Bandwidth Binge," p. 1.

[7] FCC Broadband. www.fcc.gov/broadband accessed January 27, 2007.

Broadband distribution is officially measured by the FCC by zip-code level data. If one person in a particular zip code has a broadband connection, then the FCC considers the entire zip code as being covered by broadband Internet access. For its zip-code level data, FCC collects data based on where subscribers are served, not where providers have deployed broadband infrastructure. This data may not provide a highly accurate depiction of local deployment of broadband infrastructures for residential service. According to a May 2006 report by the General Accounting Office, the way the FCC measures broadband deployment is flawed. "For its zip-code level data, the FCC collects data based on where subscribers are served, not where providers have deployed broadband infrastructure," the report notes. "Although it is clear that the deployment of broadband networks is extensive, the data may not provide a highly accurate depiction of local broadband infrastructures for residential service, especially in rural areas."[8]

### 1. Economics

The growth in international trade and interdependence is defined loosely as globalization. Globalization requires companies in the United States to be connected through broadband services to stay competitive. Broadband technology has been one of the largest facilitators in the growth of globalization over the past decade. Broadband is a leveler. It opens markets and possibilities to people who may be geographically distant from traditional centers of commerce. These are the people who could be doing valuable, productive, high-skilled work, or bringing new products to a global market, but only if they had the capacity to do so. The transparencies of the Internet have allowed people from both ends of the world to communicate and transfer services or funds via the Internet. The faster the speed of the connection means transactions can be completed quicker resulting in higher economic return. Economic strength and economic ties are proxies for Internet traffic, but Internet traffic is not the sole indicator of economic success.

Today, people can work more cheaply and efficiently from home if their access to the Internet allows for it. Companies are able to hire more competitively and save money

[8] "Broadband Deployment Is Extensive throughout the United States, but It is Difficult to Assess the Extent of Deployment Gaps in Rural Areas," p. 3.

which would be lost paying for added benefits such as travel per diem, fuel stipends, and office supplies of an employee working from the office.

### 2. Social

The Internet has changed the way people interact with one another. Socially, staying in touch with friends and relatives is as easy as a touch of a button by using email or streaming video over the Internet. Instead of face to face contact or talking over the telephone, the new way of keeping in touch with one another whether it is at the office or at home is through email and instant messaging. These applications have changed the way humans interact with one another.

As email and instant messaging have become almost ubiquitous, the social impact of such services has been felt across the country. Broadband technology has allowed for these social applications such as email and instant messaging to incorporate even more multi-media content such as streaming video and file sharing between peers. People without broadband access are automatically cut off from this world of social networking and interaction. Broadband access will be increasingly important for allowing the aged and those with physical disabilities to participate fully in society. The number of Americans aged 65 or older is expected to more than double in the next fifty years, from 36.3 to 86.7 million.[9] Many websites today depend on its users having broadband connections to deliver content at a moment's notice cheaply and securely. Unfortunately for those without broadband access, these social services are revolutionizing how people are evaluated whether it be work-related (e.g., being interviewed for a new job) or for networking within various groups.

### 3. Education

The Internet contains a mix of information both good and bad. Anything a person thinks of can most likely be explained or defined by something on the Internet. The means to making use of this information can affect how a person or even a region can become successful through education. Students that have broadband access at home or at

[9] Senior Journal.com. www.seniorjournal.com/NEWS/SeniorStats/6-04-26-FactsAboutSenior.htm accessed August 16, 2006.

school may have a competitive edge over those that do not have broadband access. Access to knowledge through the Internet is valuable and can be helpful for all sorts of educational purposes.

Broadband technology has increased the amount of information available to a user. Today a person with a broadband connection is able to access a wealth of knowledge that once was only available to tuition-paying university students or world-renowned scientists. Broadband technology has enabled users to access much more information than compared with narrow-band access. This unique access to information provides for a broader range of the population to be educated. This has the potential to start a domino effect that eventually leads to higher earning potential and higher standards of living for a region.

### 4. Emergency

Natural disasters, war, and political upheaval can often displace or sever emergency communications in an affected area. Emergency communications are now being routed and sometimes exclusively carried by wireless broadband networks within various regions or cities within the United States. The ability for individual police squad cars or fire trucks to communicate with one another and be able to know each other's location and disposition almost simultaneously has enabled faster response to emergency situations. Being able to access immense amounts of information anywhere and at anytime requires the need for broadband access to the Internet and to the situational networks which are set up for emergency purposes in areas such as natural disaster zones.

Rural communities in the United States have a disadvantage when it comes to providing emergency services. A lot of the time these communities do not have the proper funding for personnel or equipment. In addition, the ability of the emergency personnel to communicate, to access important medical data on emergency victims and having situational awareness can be restricted broadband access. The ability to coordinate and facilitate emergency response whether it is the police, ambulance, or fire personnel, can be significantly enhanced with broadband access to the Internet.

## E. HISTORICAL BACKGROUND

### 1. Phone Service

Long before the Internet was created the telephone or the use of radio waves was the only efficient way of passing information between two locations. Alexander Graham Bell is credited with the invention of the telephone in 1876. Using electricity, a sound signal is transformed into an electrical signal that is passed through some type of metallic conductor until it gets to its destination. At the destination, the electrical signal is transformed into a sound signal once again and the person on the other end of the phone line can hear what is being said.

Telephones have dominated communications throughout the world for over 100 years. The telecommunications network in the United States was devised from the very beginning to be a common carrier network with an open communications platform. This openness is suggested as being one of the reasons why dial-up narrowband Internet access took off so soon and rapidly in the United States. According to the FCC, telephone subscribership in America is 94.6 percent as of July 2006. The blanket coverage of telephone service allowed narrowband access to the Internet to become popular very quickly in the United States giving it one of the highest percentages of Internet users in the world prior to the advent of broadband technology.

### 2. Internet

In 1969, the Pentagon's Advanced Research Projects Agency Network (ARPANET) developed a variation of the technique known today as packet switching. What packet switching did was create the ability to package large pieces of data into smaller packets which could be sent over some type of medium, such as copper wire, and then be put back together at the final destination and interpreted. In 1978, after many years of advancing the packet switching technique, the Transmission Control Protocol - Internet protocol (TCP/IP) was accepted as the standard protocol to transmit data over a network using packet switching.

After the World Wide Web was developed in 1990, the Internet began growing at a constant rate at least until the late 1990's. The ability to retrieve information on almost anything made the WWW very popular which had a direct affect on the Internet and its size and speed. The digital age was born and it grew very quickly.

### 3. Broadband Emergence

The late 1990's saw explosive growth of the Internet. As more interactive and multimedia-intensive websites began to be designed for the WWW, the requirement for faster Internet access grew. People began looking to other technologies besides dial-up modems which provided faster and more reliable access to the burgeoning WWW. In 1998, cable modems offered the first broadband experience in the home. Only a few hundred thousand households subscribed to this new service in its first year, but in 1999 DSL service brought along limited competition to cable modems in the broadband market. Although broadband access through satellites was an option during the introduction of broadband, these services never became popular and have a limited share of the broadband Internet market today.

In the beginning, broadband Internet access was limited in its distribution and it was not until 2001 when broadband access to the home began to grow at a faster rate than dial-up Internet services. Although cable modems were the first to offer broadband Internet access to the home, the ability of the telecommunication companies to use their extensive telephone networks, already firmly established in all parts of the United States, gave them the lead providing broadband Internet access to the home.

### 4. 1996 Telecommunications Act

Prior to 1996, AT&T was a large telecommunications company which controlled vast portions of the telecommunication's networks in the U.S. Although efforts had been made to break up AT&T with the passing of the 1984 Telecommunications Act, more regulation was required as the digital age began to expand. More specifically, the access to broadband technology was addressed.

The Telecommunications Act of 1996 aimed to inject competition into the local telecommunications sector, but the incumbent regional telecommunications companies fought the provisions with such success that the Act's unbundling provisions were rendered largely ineffective. In the Act, Congress directed the FCC to govern the judicious deployment of Internet services that "enable users to originate and receive high quality voice, data, graphics, and video telecommunications." As of 2005, that requirement translated into an Internet connection with dependable download and upload speeds between 10 Mbps and 20 Mbps.[10] Two years have passed since that estimate was made yet home access speeds to the Internet still fail to match these requirements in the United States.

The 1996 Telecommunications Act has had its problems in litigation which has made it ineffective.

> Probably the biggest legacy of the act is litigation. We have had challenge after challenge after challenge to the rules that implemented the act, and we still don't have final rules in place, and that brings uncertainty, and uncertainty is not good for any industry, including the telecom industry.[11]

The Act was created to regulate telephone companies when it was thought the only way to compete with the incumbent telephone company was to provide another telephone service, but this logic has not carried over into the information age now that many other options are now available to compete with the telephone companies including voice over IP (VoIP) which can be used through broadband connections offered by telephone, cable, and fiber networks.

### 5. Problems

#### *a. Availability Based on Location*

Unlike the telephone networks in the United States, broadband technology does not reach nearly every household in the United States. Due to regulatory issues and simple business demands, broadband Internet providers have yet to provide broadband access to every location in the United States. Distribution of broadband Internet access is

[10] Turner, p. 2.

[11] Gregg Morton, vice president of legislative affairs for BellSouth Corp.

often densely located in areas which are economical for the companies providing services. Areas such as large cities, newly built developments being connected by fiber optics, and the suburbs are being served with broadband Internet access. Rural areas which are too sparsely populated to justify the return on investment of the broadband providers are often on the wrong side of the digital divide. Although the rural population might not be as important to the economic success of the United States as are the urban regions, they still possess a wealth of information and experiences that could be shared more easily using broadband technology.

### *b. Costs*

When compared with other countries, the United States ranks number eight in the world for broadband cost. Broadband access costs on average $0.49 per 100 Kbps in the United States.[12] Japan's cost for broadband is $0.07 per 100 Kbps, the lowest in the world. Nearly all Japanese have access to "high-speed" broadband today, with an average connection speed 16 times faster than in the United States for only about $22 a month. Even faster "ultra-high-speed" broadband, which runs through fiber-optic cable, is available throughout Japan for $30 to $40 a month.[13] The cost per bit is a reason why broadband Internet distribution and use is lower in the United States compared to many other countries around the world. Finding a way to reduce the costs either by the use of governmental policy or natural competition between broadband providers should be addressed if the United States is to be ranked as one of the top nations in the world in broadband penetration and use.

### *c. Policy Issues*

The Telecommunications Act of 1996 was supposed to bring about changes that promoted competition among telecommunication companies. In the beginning the private sector did the work, but the government offered a clear vision and strong leadership that created a competitive playing field for early broadband providers. Soon after the dot com bust in 2000, governmental leadership both in the FCC and the

[12] ITU 2006 statistics.

[13] "Down To the Wire," May/June 2005.

White House has not adapted to meet the growing obligation for universal broadband access. The Act was to provide beneficial regulations which looked out for customer's desires and demands by providing incentives for competition in the telecommunications industry, thus lowering costs and increasing the speed of broadband. Eleven years after the Act's unveiling, it has not lived up to its billing. Specifically, policy issues that were to promote broadband access distribution have in turn made telecommunication companies slow down the laying of new fiber optic cables and the creation of DSL relay stations throughout the country.

The lack of policy and plans regarding broadband access has contributed to the United States' lag in broadband penetration among the international community of broadband nations. Having a specific broadband policy will enable the United States to increase the penetration of broadband access which might have other ripple affects such as improving the economy, environment, and the social well being of its residents.

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# II. OVERVIEW OF BROADBAND INTERNET ACCESS

## A. CURRENT BROADBAND INTERNET ACCESS

"Broadband refers to a set of general-purpose electronic communications technologies rather than one specific technological solution."[14] There are several ways that broadband service can be achieved, however, the differences in service and speed are quite different. Internet usage rates for consumers may vary dramatically depending on the social, economic, or educational status. In order to explain what may be causing the broadband divide in the United States, we start with a brief description of how broadband service is transmitted to end users. On its website, the FCC states that "[broadband] transmission is provided by a wide range of technologies, including digital subscriber line and fiber optic cable, coaxial cable, wireless technology, and satellite. Broadband platforms make possible the convergence of voice, video, and data services onto a single network."[15]

Today the Internet can be delivered to the home or business location on a few different mediums. Depending on the price, location, and need, a customer may be able to choose from a wide array of options or be forced to use whatever is available. The five delivery methods are through copper wire, coaxial cables, fiber optics, satellite signals and various 802.11 wireless protocols. The wide disparity of available options across the United States has led to what is known as the broadband divide in the United States.

In the United States the most common broadband access technology is cable modem. On the world stage, DSL ranks ahead of cable modems as the number one technology used for broadband Internet access. As of June 2006, 63% of world-wide broadband connections are provided by DSL, 29% are provided by cable modems and 8% are provided by other technologies (e.g. satellite, fiber and fixed wireless). [16]

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[14] Bauer, p. 3.

[15] FCC Broadband. www.fcc.gov/broadband/ last viewed on January 26, 2007.

[16] OECD Broadband statistics.

### 1. Copper Wire

Copper is malleable, ductile, and a good conductor of heat and electricity (second only to silver in electrical conductivity).[17] These properties make copper an excellent choice for making wiring used by the telecommunications industry worldwide. Having no idea of the scope of their findings, Alexander Graham Bell and Samuel Morse, two pioneers in telecommunications that invented the telephone and telegraph respectively, developed the idea that data could be transmitted through copper wire.

The telephone network in the United States was almost exclusively made up of copper wiring up until April 1977 when the first live telephone conversations were transmitted through fiber optics.[18] Copper wire's cost and simplicity allowed for every community in the United States to be reached by the copper telephone networks. The vast customer base that the telecommunications industry possessed provided an excellent opportunity for the broad distribution of narrowband Internet access.

By using a modem, data can be transferred on the same copper wires which also transmit telephone signals. Modems were first used in the 1960s. The speed of these early modems was around 300 bps. During the 1980s and 1990's, modem technology advanced from 300 bps to the now standard 56 Kbps which is the high end speed limit of dial-up modems in use today. The speed advancement was enabled through advances made in echo cancellation, and new coded modulation with error correcting codes. The table below shows the progression of modem speeds through a series of time frames which lasted for two years on average.

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[17] Los Alamos National Laboratory-Copper.

[18] Hecht, p. 243.

| **Speed** | **Time Frame** |
|---|---|
| 300 bps | 1960s -1983 |
| 1200 bps | 1984-1985 |
| 2400 bps | 1986-1989 |
| 9600 bps | 1990-1991 |
| 14.4 Kbps | 1991-1994 |
| 28.2 Kbps | 1994-1995 |
| 33.6 Kbps | 1996-1998 |
| 56 Kbps | 1998 |
| ADSL –up to 8 Mbps | 1999-present |

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Table 2. Modem Speeds from 1960 to 1999 (From How Stuff Works-Dial Up Modems).

Up until about 1996, the most common carrier of Internet traffic to private households was copper wiring through the use of a dial-up modem. The Internet was small and had not yet begun to expand at its rapid growth rate that was present in the late 1990s till present day. There was not a great necessity to have data speeds higher than 56 Kbps due to the content of the Internet and the relatively limited user base. For that reason, dial-up modems met the requirements of most end-users and provided for easy and inexpensive access to the Internet.

The extensive telephone networks throughout the country also provided an excellent customer base for new ISPs. With the purchase of a dial-up modem and a monthly service fee, customers could try out the Internet. ISPs instantly had customers without having to build any kind of infrastructure that had to be added to the existing copper telephone network. The copper wiring which provided telephone service also was able to provide Internet access.

Increasing demand for Internet applications and data requirements eventually began to push the upper limits of dial-up modems. Internet users wanted faster and more

dependable Internet service. Narrowband Internet access did not provide Internet users the quality of service required in order to view the changing face of the WWW.

### *a. Digital Subscriber Line (DSL)*

Originally created to deliver video over existing copper wire, Digital Subscriber Line (DSL) service was developed in 1989 by Joseph Lechleider. Through mathematical analysis, Lechleider demonstrated the feasibility of sending broadband signals through copper wiring. This established his place in history as the originator of broadband technologies. This was the beginning of the move from analog to digital signaling in the telecommunications industry. John Cioffi, who eventually became a Stanford University professor, developed DMT (discrete multi-tone) which is a method of separating a DSL signal into 256 frequency bands or channels. DMT is able to allocate data so that the throughput of every single sub channel is maximized. Sub channels that are not able to carry data for one reason or another can be turned off and the use of available bandwidth is optimized.

DSL is a broadband technology that uses the same wires as a regular telephone. Unlike regular voice conversations which travel on the telephone line using a limited range of frequencies, DSL technology exploits the extra capacity of the copper wire by using other frequencies to transfer data at the same time. This increases the bandwidth the copper wire has to carry information. Plain Old Telephone Service (POTS) makes the most of the telephone company's wires and equipment by limiting the frequencies the switches, telephones, and other equipment will carry. Human voices in conversational tone can be carried in a frequency ranging from 0-3,400 Hertz. Compare this to the range of most stereo speakers which cover a range of 20 Hertz to 20,000 Hertz.

The reason the telecommunications industry utilized such a small portion of the bandwidth on the copper wires is due to its history. Two copper wires have been needed for a telephone line to home for over a century. By limiting the frequencies carried by the copper wires, the telephone system can pack lots of wires together in a small space and not have to worry about interference between two different wires. Modern equipment has now made the interference problem an issue of the past since

digital signals can be sent on the wires instead of analog signals which eliminate or significantly reduce interference.

A few advantages of DSL over regular dial-up modems are the Internet connection can be left open while still using the phone line for voice calls, a dramatic increase in speed, there is no new infrastructure needed on the user's end, and the company providing the DSL service usually provides the modem as part of the installation package. However, DSL is not without disadvantages. The service area is limited by the distance from the central office. The farther away a customer is from the central office, the slower the broadband Internet connection. Since distance has affect on the availability of DSL, not all areas being served by the telephone networks are able to access the Internet using DSL. In the United States, ADSL and HDSL have found the widest implementation, with ADSL being more popular for home usage.

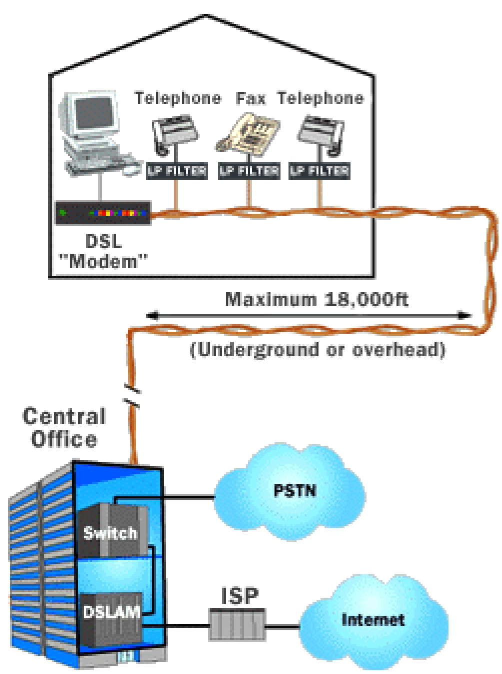


Table 3. How DSL Works (From How Stuff Works-DSL).

There are many variants of DSL. Distance from the provider's central office, the quality of the copper wire and number of copper lines determine the category of DSL. Distance has the largest impact on DSL service. Customers who are closer to

the provider's central office receive faster service than those furthest away. Voice telephone calls are not bothered by the decline in performance like DSL is due to distance from the provider's central station. Small amplifiers called loading coils are placed on the telephone lines which boost the voice signals. These loading coils are incompatible with the DSL signal which prevents the DSL signal from being able to pass through the loading coil and ultimately working at distances longer than 18,000 feet. There is a bit of hope, however.

Newer repeater technology is enabling telephone companies to provide DSL beyond the 18,000 ft barrier. This is good news for businesses requiring broadband access to the Internet. A newer international standard G.SHDSL (G.991.2) was developed from the ground up by the ITU in 2001. It is capable of delivering symmetric data rates from 192 Kbps to 2.3 Mbps using one pair of copper lines and from 384 Kbps to 4.6 Mbps using two pairs of copper lines. It also incorporates newer technology that can boost DSL signals past the 18,000 foot limit by placing repeaters along side the loading coils.

| **DSL Type** | **Maximum Distance From Service Provider's Premises** | **Speed** |
|---|---|---|
| ISDL | 18,000 ft | 144 Kbps |
| ADSL (Asymmetric) | 18,000 ft | 64 Kbps-1.54 Kbps Upload, 256 Kbps-9 Mbps Download |
| ADSL Lite (G.lite) | 18,000 ft | 512 Kbps Upload, 1.5 Mbps Download |
| SDSL (Single Line) | 10,000 ft | 1.5 Mbps (Upload and Download) |
| HDSL (High Bit-Rate) | 12,000-15,000 ft | 1.544 Mbps or 2.048 Mbps (Upload and Download) |
| VDSL (Very High Bit-Rate) | 1,000-4,500 ft | 13-52 Mbps Download, 2.3 Mbps Upload |

Table 4. Various DSL services with rough estimates of real-time performance.

DSL was able to provide an improvement over a regular dial-up modem in terms of speed and quality of connection, however, DSL technology has reached its upper limit in capacity and distance that it is able to function. Building more central offices which can relay DSL signals over a larger geographical area is quite expensive for the telecommunications industry to invest in and often the return on investment is minimal. That being said, DSL is an inexpensive option for an ISP to enter into the broadband market since the infrastructure needed to operate DSL service, regular telephone lines, is already in place.

### *b. Unshielded Twisted Pair Cabling*

There are many different types of unshielded twisted pair cabling. Twisted pair cabling is used for purposes of canceling out electromagnetic interference from external sources and crosstalk from neighboring wires. The category of cabling is determined by the number of twists in the wires per meter. POTS lines use a type of unshielded twisted pair cabling called Category One cabling (CAT 1). It consisted of two copper wires that are twisted around each other. Twisted pair cabling was first used by Bell in 1881 and by 1900 the entire American telephone network was twisted pair or some version that provided the same benefits of twisted pair.[19] Category five (CAT 5) has been used for networking computers for many years and is the standard medium that is used when setting up Ethernet in an office or at home.

[19] Twisted Pair, from www.en.wikipedia.org/wiki/Twisted_pair accessed February 4, 2007.

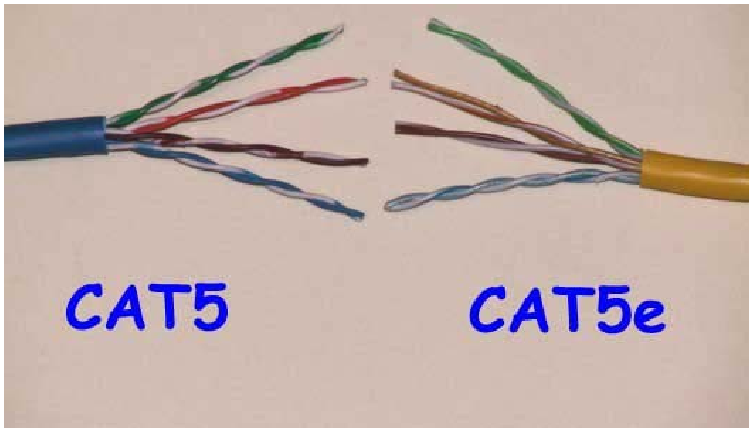


Figure 2. Picture of CAT 5 and CAT 5e cabling (From Catanzarite).

There are several different types of unshielded twisted pair categories. Each has its own advantages and disadvantages, but the property that all of them have is the short distance they can be used. Twisted pair wire is not used often to provide broadband Internet access directly from a telephone central office due to the distance limitation. It is generally used in large buildings or to provide broadband service between buildings in the same general area. The distance that twisted pair cabling works over is small when compared to regular telephone lines or fiber optics.

| Type | Use |
|---|---|
| Category 1 | Voice Only (Telephone Wire) |
| Category 2 | Data to 4 Mbps (LocalTalk) |
| Category 3 | Data to 10 Mbps (Ethernet) |
| Category 4 | Data to 20 Mbps (16 Mbps Token Ring) |
| Category 5 | Data to 100 Mbps (Fast Ethernet) |

Table 5. Categories of Unshielded Twisted Pair (UTP).

A new type of use for twisted pair in the form of Ethernet is gaining popularity due to its reduced expense but similar capacity of T1 or T3 lines that provide broadband access to businesses. Ethernet is a solution that is able to provide high-speed Internet access to a user by making use of the copper wiring already in place covering that “first-mile” from the user’s home or business to the larger fiber or copper nodes which reside within the community. Although the distances are short, Ethernet can connect high-density business buildings or neighborhoods to the Internet. It may be an

option to bridge the gap between the older copper technology and the newer fiber technology which is expensive to install.

The Institute of Electrical and Electronics Engineers (IEEE) established a working group that established new standards for using copper as a first mile access technology for Ethernet metropolitan and wide area networks. The IEEE 802.3ah embraces both fiber and copper in the physical layer. There are two new standards for increasing the speed of copper transmissions. 2BASE-TL offers a minimum of 2 Mbps over distances of up to 9,000 ft with a nominal speed of 5.7 Mbps. Up to eight pairs can be bonded to deliver similar bandwidth to a 45 Mbps T3 line. The other standard is 10-PASS-TS. This is a shorter range technology that delivers a minimum of 10 Mbps up to 2,460 ft. 10-PASS-TS also supports pair bonding to increase bandwidth.[20] Carrier Ethernet gains strength for wide area networking, the EFM or Ethernet in the First Mile standards from the IEEE seem like a good match for access to the metropolitan and long-haul networks.

#### *c. Coaxial Cable*

Another way to access the Internet is through Community Antenna Television (CATV). Coaxial cable which is commonly used to transport cable television to millions of houses in the United States can also be used to transport data from the Internet. Coaxial cabling consists of two conductors separated by some type of dielectric. The inner conductor is typically a straight wire which can be solid or stranded and an outer conductor which is typically a shield that might be braided or some sort of foil. Because of its shielded, concentric construction, coaxial cabling is much less susceptible to interference and crosstalk than twisted pair.

[20] Shepler, January 2007.

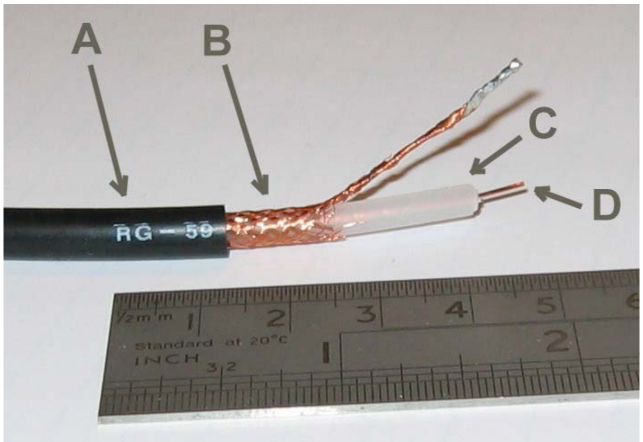


Figure 3. Coaxial cable. A) outer plastic sheath B) copper screen C) inner dielectric insulator D.) copper core. (From www.wikipedia.org-Cooper)

The difference in construction between coaxial and twisted pair cabling allows for it to operate over a wider range of frequencies and longer distances than twisted pair cabling. Although originally used to transmit radio, long-distance phone transmissions, and set up local area networks, the use of coaxial cabling spread rapidly when it was first used to transmit TV signals to individual homes. Cable TV (CATV) systems can carry dozens or even hundreds of TV channels at ranges up to a few tens of kilometers.

With simple upgrades in software and the addition of a cable modem, CATV subscribers can connect to the Internet at broadband speeds. A cable modem provides access to a data signal which is sent over the cable television infrastructure. The abundance of unused bandwidth available on the cable TV infrastructure's coaxial cabling allows for broadband Internet access. Typically, cable modems are able to provide anywhere between 384 Kbps through 6 Mbps and higher for home connections and from 3 Mbps to 30 Mbps or more for business connections.

The advantage of using coaxial cabling for broadband service is that the broadband signal quality does not diminish with distance. Unlike twisted pair and DSL, coaxial cabling provides the same signal quality to a customer a few kilometers away from the provider's office as it does to the customer hooked up just a few feet away. Along with the added advantage of signal quality comes with it some negative aspects of high costs and time-intensive labor to install coaxial cabling.

The biggest drawback of CATV broadband Internet access is that all users have to share the bandwidth available on the single coaxial cable that each user is hooked up to. That means the more users that are using the broadband connection simultaneously the less bandwidth each can be allocated. This can slow the broadband connection down considerably in a neighborhood if every user decides to access the Internet at the same time. Connection speeds, therefore, can fluctuate throughout the day as more or less customers are using the Internet.

### 2. Fiber Optics

Some 10 billion bits of information can be transmitted per second along an optical fiber link in a commercial network, enough to carry tens of thousands of telephone calls or WWW pages by way of the Internet. Although copper wire and CATV dominate the broadband dispersion in the United States, fiber optics are beginning to dominate as the medium carrying data for the Internet in isolated communities around the country. Commercially introduced to the world in the late 1970s in Chicago and Boston by AT&T and GTE respectively, fiber optics provided the fastest connection for any customer wishing to connect to the Internet.

Optical fibers are used in fiber optical communication which can carry data over longer distances and at higher speeds than traditional electronic communication. Light signals are used to encode data that can be transmitted over optical fibers. Using light eliminates the possibility of interference from moisture, heat, and other electrical signals. Unlike copper wiring, fiber optic cables are not affected by the effects of corrosion so less money is spent on cable maintenance whereas copper wires can be susceptible to corrosion from weathering and age.

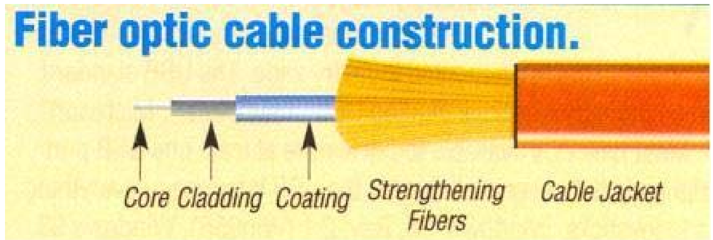


Figure 4. Basic fiber optic cable construction (From www.arcelect.com).

Fiber optics technology is rather new compared to traditional copper wire telephone lines. It has only been used in the telecommunications industry since the late 1970s. The basic function of fiber optics is to transport a light signal through a glass fiber which can be converted into an electrical signal that can be interpreted by networking equipment. Fiber-optic technology can transmit data, video, and voice in the form of light over glass. The advantage of using light over electrical signals as that light has low attenuation and interference properties when compared with electrical signals that travel over copper. The low loss of signal strength over long distances and its inherently high data-carrying capacity gives fiber optics a distinct advantage over long-distance carrying copper wire. On a single strand of fiber no thicker than a human hair, a feature-length film can download in 4 seconds. Its smaller size, electrical resistance and immunity to electromagnetic interference make fiber optics an appealing choice for broadband Internet access, but optical fiber also has some drawbacks.

Using fiber optics for short distances and for low bandwidth applications is not as economical as copper wire. Fiber optics is difficult to splice, the costs of transmitters and receivers are more expensive than copper, and the material costs are lower where large quantities are not required. Although it is less expensive to produce the glass fibers used in fiber optics, the infrastructure required to join the technology with the telecommunications network along with the civil work of digging, laying and hooking up the fiber is expensive. Often, the higher expense of the fiber could be offset by using it to replace the copper long-distance phone lines since the full capacity of the fiber could be used. Now the cost of fiber optics is falling due to new manufacturing processes and the reorganization of some of the large telecommunications companies. The cost per subscriber for fiber-to-the-home (FTTH) in 2003 was approximately $2000, and now that

cost has dropped below $800 by the end of 2006 making it affordable to telephone companies to roll out fiber instead of copper.[21]

When fiber is used to provide broadband, there are three main situations in which it can be used. The first is FTTH. FTTH provides a fiber connection all the way up to the consumer's home or business from the central office or backbone. This provides the fastest speed and most capacity out of the three uses. Fiber-to-the-curb (FTTC) only goes to the curb near the consumers and then usually relies on copper telephone line to complete the connection to the consumer. This is a little cheaper to install for the telecommunications companies because the fiber can make use of existing copper telephone lines that run from the curb to the consumer's home or business. The last use is called fiber-to-the-node (FTTN). This is the least expensive for the telecommunications companies to install since the fiber only goes to a node in a local network or loop. From there copper telephone lines are usually used again to supply all the homes and businesses in the area with broadband and then it all congregates at the fiber node to be sent to the central office.

### 3. Wireless

#### *a. 802.11 (WiFi)*

Wireless Fidelity (WiFi) is also known as the 802.11 standard. Standardized in 1997 by IEEE, the 802.11 standard has been updated numerous times since. Wireless broadband service is extremely popular now at university campuses as well as in commercial areas such as coffee shops, hotels, malls, airports, etc. Wireless broadband has even been introduced to large city populations for free such as in Philadelphia, New Orleans, and soon in 2007-2008 to San Francisco. Almost all laptop computers come with a wireless networking card that is required when connecting to a wireless network while away from the land-line broadband connection which is provided at home or in the office. What wireless might lack in distance serviced, it makes up for with the ease of setup and the cost savings in infrastructure.

[21] Wieland, p. 1.

The ubiquity of mobile devices has driven the wireless networking environment to become a popular choice for broadband service even with its inherent security problems. Wireless broadband service can be susceptible to environmental conditions such as rain, fog, or humidity. In enclosed environments such as university buildings or airports these conditions do not exist, however, in open air spaces such as outdoor coffee shops, open campuses and neighborhoods, the environment can play a significant role in the quality of service that wireless broadband provides. 802.11 wireless services are also susceptible to interference problems caused by other devices operating on or near the same frequency as the 802.11 service. 802.11 service runs on either 2.4 GHz or 5 GHz bands depending on the version of the 802.11 protocol. Many devices such as cordless phones, baby monitors, microwaves, wireless phones, and other 802.11 devices can all cause interference problems and slow or prevent the broadband Internet access.

| **Protocol** | **Release Date** | **Op. Frequency** | **Data Rate (Typical)** | **Data Rate (Max)** | **Range (Indoor)** | **Range (Outdoor)** |
|---|---|---|---|---|---|---|
| Legacy | 1997 | 2.4-2.5 GHz | 1 Mbps | 2 Mbps | ~25 meters | ~75 meters |
| 802.11a | 1999 | 5.15-5.35/5.47-5.725/5.725-5.875 GHz | 25 Mbps | 54 Mbps | ~25 meters | ~75 meters |
| 802.11b | 1999 | 2.4-2.5 GHz | 6.5 Mbps | 11 Mbps | ~35 meters | ~100 meters |
| 802.11g | 2003 | 2.4-2.5 GHz | 25 Mbps | 54 Mbps | ~25 meters | ~75 meters |
| 802.11n | 2007 (draft) | 2.4 GHz or 5 GHz bands | 200 Mbps | 540 Mbps | ~50 meters | 125 meters |

Table 6. Summary of 802.11 protocols (From wikipedia.org-IEEE 802.11).

Since 802.11 protocol is based on radio waves passing through the air, distance plays a factor is how strong a signal can be which affects the speed at which the protocol can provide broadband Internet customers. Depending on what version of the

protocol is used, distance away from the access point, and interference from other devices, the 802.11 protocol can provide broadband speeds anywhere from 2 Mbps to 54 Mbps. Actual throughput estimates are much lower due to the 802.11 protocol's high overhead that is required to maintain connections. The 802.11 protocol is also constrained by the backhaul in which it is hooked up to.

Quality of service (QOS) has a large affect on the type of service a broadband consumer might decide upon. Wireless broadband service may not provide the best QOS when compared with the wired broadband services, but it does add a level of mobility which cannot be matched. In the consumer's mind, the mobility advantage of wireless will sometimes become more important than the level of QOS wired broadband solutions provide. Providers may use this to their advantage when deciding on the type of broadband service to deploy. To save costs and lessen the setup time in providing broadband service, a provider may chose wireless over a wired solution.

***b. Satellite***

Satellite technology can provide broadband Internet access to remote or sparsely populated areas. Speeds range from up to 500 Kbps for downloading and 80 Kbps in the upload direction, but it can vary depending on a few factors such as weather, the consumer's line of sight to the orbiting satellite, and what kind of service package is purchased. The speeds are considerably slower than DSL or cable modems; however, satellite broadband Internet access is about 10 times faster than dial-up Internet access which can make it a viable option for someone that does not have access to other broadband technologies.

Similar to satellite television, satellite broadband works by sending directed radio waves into space where satellites direct the signal towards a base station on the ground where there is some type of broadband backhaul that travels on another broadband technology like fiber optics or coaxial cabling. The main drawback is its expense and limited speed. Sending satellites into space can be expensive. Recouping the cost of sending a satellite into space can take a while especially with a limited customer base. Latency becomes noticeable when applications such as VoIP or

interactive gaming are used. There is a built in quarter second delay for radio signals to travel from the ground to the satellite in space. This latency can be reduced by taking out inefficiencies in the applications, but there will always be the physical speed that data can travel by way of radio signals all the way to the satellite in space.

#### *c. Cellular*

The use of cellular technology to provide broadband service is limited in the United States because of coverage issues. The new 3G cellular networks boast download speeds from 144Kbps (roughly three times faster than a 56K dial-up modem connection) to 2.4Mbps (close to cable-modem speed). Although the speed is a welcome increase over traditional dial-up modem speed and comparable with DSL and cable modems, 3G cell networks are costly to subscribe to and they are not common yet in the United States.

The common cellular broadband technology in the United States is the EV-DO (Evolution-Data Optimized) network. Broadband speeds of 400-700 Kbps are available on the EV-DO network, but the upload speeds are only in the 50-70 Kbps range. The price for broadband access through the EV-DO network is still rather expensive. Cellular phone companies Sprint, Verizon and Cingular offer standalone, two-year, unlimited EV-DO broadband data plans for $80 a month with highly restrictive terms of service.[22]

A newer version of EV-DO is on its way. EV-DO Revision A is expected to be able to upload data at 300-700 Kbps. Sprint and Verizon will be offering this service in early 2007. Maintaining excellent reception on a cell phone is also required in order to maintain the maximum download rate. This is difficult if a person is in a building or being blocked by some geographic feature such as a hill or mountain.

[22] Captain, p. 1.

## B. EMERGING BROADBAND TECHNOLOGY

### 1. Power Lines

By superimposing an analog signal over standard 50 or 60 Hz alternating current electrical power lines, data can be transmitted over the electrical grid. Broadband over power lines is a concept that has gained popularity in rural areas of the country as well with use in personal home networks. Although the idea of sending data through the electrical grid is not new, developing ways to boost and speed up the data capacity of a power line is starting to evolve quickly. The extensive infrastructure already in place in the United States makes sending broadband over a power line a promising solution to the broadband divide in the United States.

The FCC coined the term BPL (Broadband over Power Line) in 2004 when it adopted rules to facilitate the use of broadband over power lines. In 2006, the FCC then adopted the Memorandum Opinion and Order on BPL which gave the FCC permission to officially promote BPL. BPL will only work on mid to low voltage power lines. High voltage lines carry power that is anywhere from 155,000 to 765,000 volts which produces too much noise for the broadband signal to be passed simultaneously with the electricity. Medium voltage lines which carry 7,200 volts can carry the broadband signal with the help of repeaters that boost the broadband signal as it degrades.

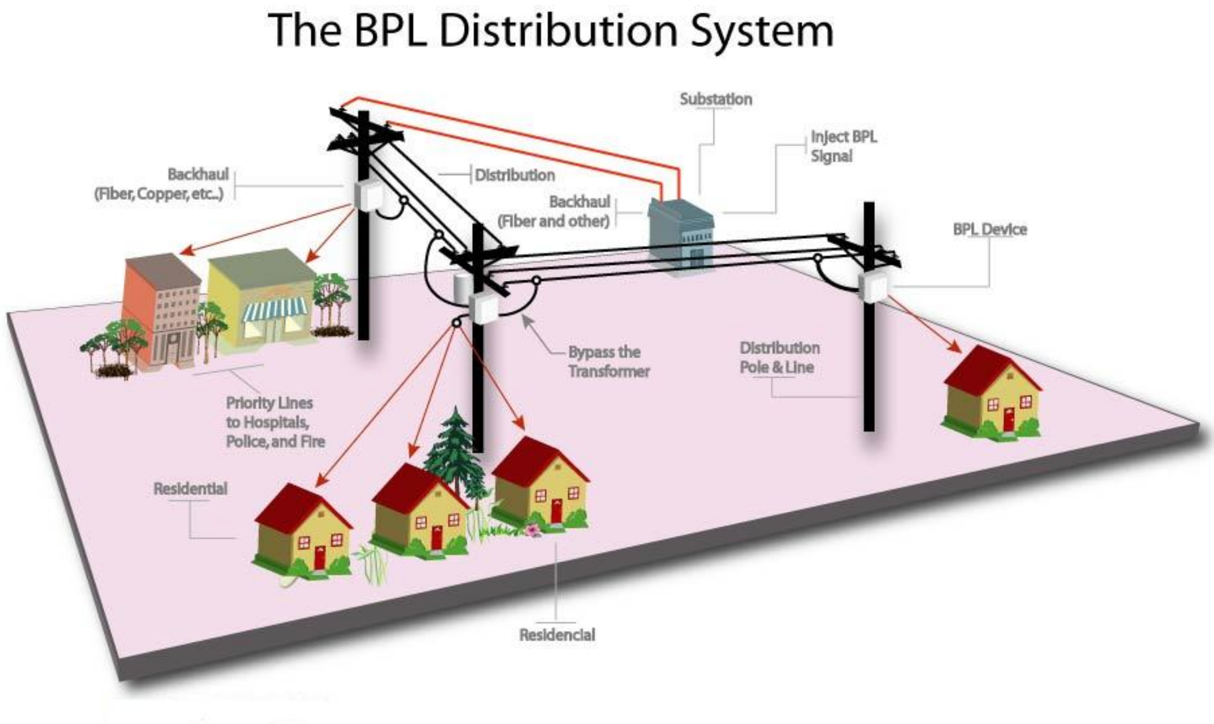


Figure 5. The BPL Distribution System (From www.plexeon.com).

The standard in the United States for power that arrives at the home is 240 volts. In order to reduce the medium-voltage power lines to 240 volts, the electricity must pass through a transformer. BPL signals cannot pass through this transformer so there must be couplers at every transformer in order for the broadband signal to bypass the transformer. All that is required in the home to use BPL is a BPL modem that is about the size of a common power adapter. Speeds ranging from 256 Kbps to 3 Mbps are possible for the home or business which is comparable to the speeds provided by DSL or cable modems. BPL technology potentially enables electric utilities to become triple play communications providers with minimal investment in infrastructure.

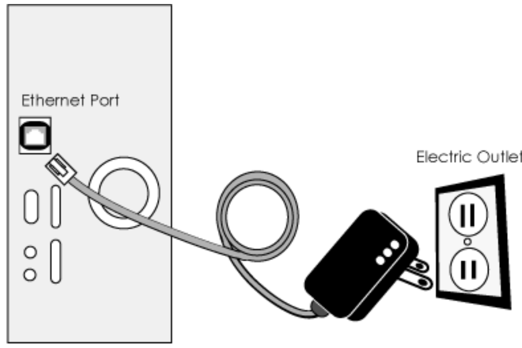


Figure 6. BPL modem being hooked up to a computer's Ethernet port (From HowStuffWorks.com-BPL).

Some issues must be further researched before BPL can become a superior broadband Internet provider. In the United States, the power grid usually adheres to having a small transformer per every household or business being served. In Europe, where the power grids are set up differently, there are larger transformers that usually service multiple homes or businesses. This difference means that many couplers are necessary in the United States in order to enable the power grid to carry BPL, whereas in Europe, the smaller number of transformers and higher amount of households connected to each transformer equates to less couplers being needed to provide the same BPL service. No common standard has been adopted yet for BPL usage even though the FCC has taken the step to promote it. BPL cables cannot be segmented and have a poor and unpredictable frequency response, thereby suffering from strict limits on the total capacity of any BPL system. Thus, it remains to be seen whether BPL will develop into a competitive broadband technology on a meaningful scale. This might be a hurdle in the distribution of BPL as a viable alternative for broadband Internet access.

#### 2. 802.16 (WiMAX)

WiMAX is the IEEE 802.16 standards-based wireless technology that provides MAN (Metropolitan Area Network) broadband connectivity. It is a technology that shows great promise in solving the "last-mile" problem of connecting homes and businesses to the Internet through a fixed broadband connection.

WiMAX systems use microwaves to transport data at broadband speeds over long distances without having to be within the line of sight of the consumer. Ranges over

which broadband Internet signals can be transmitted are up to 30 miles. This differs greatly compared with the 802.11 WiFi standards in which the effective distances measure in feet rather than miles. Operating in the 2GHz-66GHz range, WiMAX has the flexibility of adapting to available spectrum ranges in various areas around the country. WiMAX's channel sizes range from 1.5 to 20MHz which enables broadband services on one channel to support rates from 1.5 Mbps up to 70 Mbps.[23]

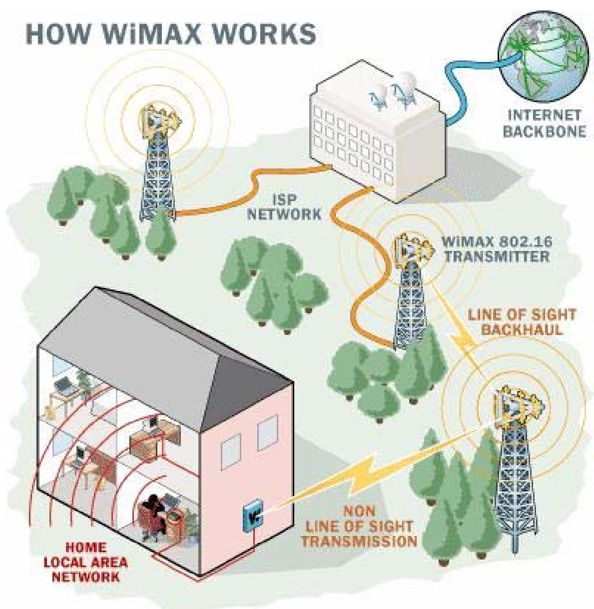


Figure 7. WiMAX setup (From www.library.thinkquest.org).

Set up similar to a cell phone network, WiMAX towers can be co-located with cell towers and provide extensive backhaul capability for cellular networks. This allows the cellular base stations to bypass the Public Switched Telephone Networks (PSTN). WiMAX can also be used as a backhaul for WiFi hotspots where broadband access is not yet available through cable or DSL. The cost savings in setting up WiMAX has over installing new fiber or cable networks can be very attractive to telecommunications companies wishing to provide broadband Internet access to areas not yet served by other broadband technologies. Due to the relative newness of this technology, certified

[23] Song, p. 1.

WiMAX products adhering to the 802.16 IEEE standard are just beginning to be released on the market.

### 3. Unused Television Channel Frequency

The IEEE 802.22 Working Group has started to develop the IEEE P802.22 standard which makes use of geographically unused television channels, known as “white space,” to provide a way of delivering broadband Internet access. Signals using the 54-698 MHz frequency range on the TV spectrum can propagate 40 km or more from a well-sited base station, depending on terrain.[24] Using this “white space” in the TV channels will open up a large broadband market in areas around the United States and the world where more traditional broadband technologies are not available or are too expensive, especially in sparsely populated areas where wireline broadband service is not economical due to the distance between customers and the central offices.

In May of 2004, the FCC initiated a rulemaking (Docket 04-186) to open up the use of unlicensed devices to operate in the broadcast television spectrum at locations where the spectrum is not in use by television stations.[25] The physics behind the propagation of television signals give it an advantage over traditional unlicensed wireless methods such as 802.11 because the lower frequency television signals can travel further and are able to better penetrate physical obstacles such as building walls. This idea did not take off like it was expected to due to the powerful television companies dragging their feet. On January 9, 2007, Senators John Kerry (D-MA) and Gordon Smith (R-OR) introduced the Wireless Innovation Act of 2007 to expand broadband access by opening up unused TV channels (“white spaces”) across the United States for unlicensed use by wireless broadband devices.[26] This legislation should make the use of the “white spaces” in the television signal spectrum easier to use for broadband purposes.

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[24] TV Spectrum announcement by IEEE. www.standards.ieee.org/announcement/pr_80222.html accessed on February 7, 2007

[25] FCC website.

[26] “From Broadcast to Broadband,” p. 1.

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# III. BROADBAND IN THE UNITED STATES

## A. BACKGROUND

There have been many promises and determined goals set forth since the early 1990’s on improving America’s broadband access and distribution problems. Starting in the early 1990's, the Clinton-Gore Administration had aggressive plans to create the "National Infrastructure Initiative" to rewire all of America with fiber optic wiring, replacing the 100 year old copper wire. Pending financial incentives from the government, the Bell companies — SBC, Verizon, BellSouth and Qwest — told the government that they would make an concerted effort to rewire homes, schools, libraries, government agencies, businesses and hospitals, etc.[27] Policy and lobbying issues eventually stalled any efforts for the new wide spread fiber optic networks, and the telecommunications companies focused more on the cheaper and proven business models of deploying and fixing the older copper networks already established. President George W. Bush also made a similar policy statement in March 2004 when he stated all Americans should have universal and affordable access to broadband service as well as ensure there are plenty of broadband provider choices to choose from by 2007.

In fact, since 2001, the U.S. has fallen from number four to number 12 in the world in broadband use per capita.[28] The United States boasts the world’s largest broadband market. The sheer number of broadband users in the United States is between 56-64 million as of June 2006 depending on what source is used.[29] The United States does have more broadband users than any other country in the world, but according to the latest OECD report on broadband penetration (see Appendix A), only 19.2 percent of the United States’ population have broadband service. A more reliable survey of the public was done in a study by the Government Accounting Office in 2005. In that study, an estimated 28 percent — or about 30 million — American households subscribed to

[27] Kushnick, p. 1.

[28] OECD Broadband Statistics.

[29] The FCC in its latest broadband report lists 64 million broadband users but the OECD report lists 56.5 million broadband users. The difference may be in what is measured. The FCC measures all business and residential broadband lines while the OECD may only measure residential lines.

broadband service; this number has increased dramatically since 2005. Although this statistic does not show the complete picture of broadband distribution in the Unites States, it does cast a shadow on the United States' broadband policy and governmental regulation.

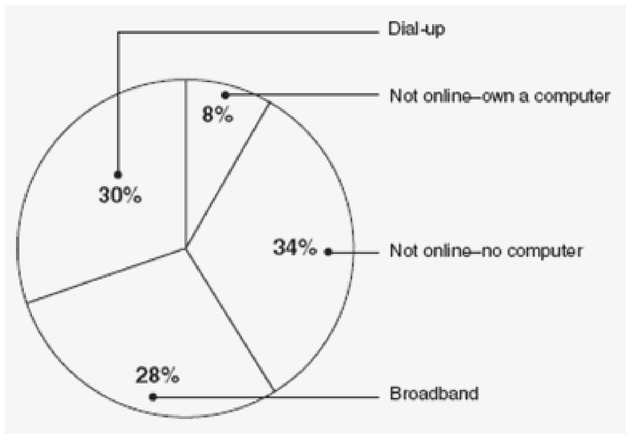


Figure 8. Status of Household Computer Ownership and Internet Connection in 2005 (From GAO).

## B. COMPOSITION OF THE BROADBAND MARKET

Broadband Internet distribution is measured by the FCC using three different population-based categories: urban, suburban, and rural areas. Urban consists of the areas which are within large cities, suburban consists of those areas just outside of the large cities but within commuting distance, and rural consists of those areas that are sparsely populated and not near large cities. Telecommunication companies decide to offer broadband in the different areas based on several factors such as markets, technology, regulation and resources.

In the United States, broadband is primarily provided either by DSL or cable modem. Fiber optics and wireless broadband providers do not provide a significant percentage of the broadband Internet access yet, but both of those broadband technologies are growing in specific areas of the country. DSL and cable broadband access both provide significant increase in speed over traditional narrow band Internet

access, but they still do not provide near symmetrical access which is required as Internet users post more information to the Internet instead of just downloading it.

| Technology | 2000 | 2001 | 2002 | 2003 | 2004 | | 2005 | | 2006 |
|---|---|---|---|---|---|---|---|---|---|
| | Jun | Jun | Jun | Jun | Jun | Dec | Jun | Dec | Jun |
| ADSL | 951,583 | 2,693,834 | 5,101,493 | 7,675,114 | 11,398,199 | 13,817,280 | 16,316,309 | 19,515,619 | 22,575,010 |
| SDSL and Traditional Wireline | 758,594 | 1,088,066 | 1,186,680 | 1,215,713 | 1,407,121 | 1,468,566 | 898,468 | 904,539 | 948,160 |
| SDSL | - | - | - | - | - | - | 411,731 | 394,348 | 337,438 |
| Traditional Wireline | - | - | - | - | - | - | 486,737 | 510,191 | 610,722 |
| Cable Modem | 2,284,491 | 5,184,141 | 9,172,895 | 13,684,225 | 18,592,636 | 21,357,400 | 23,936,536 | 26,469,242 | 28,513,500 |
| Fiber [3] | 46,635 | 81,248 | 105,991 | 111,386 | 130,928 | 159,653 | 315,651 | 448,257 | 700,083 |
| Satellite and Wireless | 65,615 | 194,707 | 220,588 | 309,006 | 421,690 | 549,621 | 965,068 | 3,814,122 | 11,872,309 |
| Satellite | - | - | - | - | - | - | 376,837 | 426,928 | 495,365 |
| Fixed Wireless | - | - | - | - | - | - | 208,695 | 257,431 | 360,976 |
| Mobile Wireless | - | - | - | - | - | - | 379,536 | 3,129,763 | 11,015,968 |
| Power Line and Other | - | - | - | - | - | - | 4,872 | 4,571 | 5,208 |
| Total Lines | 4,106,918 | 9,241,996 | 15,787,647 | 22,995,444 | 31,950,574 | 37,352,520 | 42,436,904 | 51,156,350 | 64,614,270 |

Table 7. High Speed Lines in the U.S. (From FCC).

As of June 2006, 1,323 companies offered broadband service in the United States up from 105 in 1999.[30] 832 of those companies provided DSL service, 253 cable modem service, and 814 firms offered other technologies. According to the data collected by Leichtman Research Group, the top-five broadband providers (see table eight) supplied 63.4 percent of all broadband connections. The top 10 companies supplied 83 percent, and the top 20 supplied 95 percent of the broadband connections. The remaining five percent is made up of more than 450 companies that offer some type of broadband service. Only three of the companies that provide broadband access in the United States since 1990 rank in the top 20 service providers.[31]

[30] FCC 2006b, Table 7.

[31] Fransman, p. 134.

| Broadband Internet Provider | Subscriber adds in 3Q 2006 | Net Adds in 3Q 2006 |
|---|---|---|
| **Cable** | | |
| Comcast | 11,000,000 | 536,000 |
| Time Warner | 6,398,000 | 251,000 |
| Cox | 3,200,000 | 75,000 |
| Charter | 2,343,200 | 88,100 |
| Cable Vision | 1,963,880 | 72,438 |
| Insight | 579,300 | 44,800 |
| Media Privately Held Companies | 1,575,000 | 80,000 |
| **Total Top Cable** | **28,148,814** | **1,202,510** |
| **Telephone Companies** | | |
| AT&T | 8,148,000 | 374,000 |
| Verizon | 6,583,000 | 448,000 |
| Bell South | 3,449,000 | 176,000 |
| Qwest | 1,973,000 | 175,000 |
| Embarq | 993,000 | 84,000 |
| Windstream | 603,114 | 55,268 |
| Covad | 531,648 | (16,341) |
| CenturyTel | 340,000 | 27,147 |
| Cincinnati Bell | 187,000 | 12,200 |
| **Total Top Phone** | **22,738,462** | **1,334,274** |
| **Total Broadband** | **50,887,276** | **2,536,784** |

Table 8. Top 20 Broadband Providers in the U.S. (From Leichtman Research Group, Inc.).

In the United States, the top five states in residential broadband penetration at the end of 2005 were New Jersey, Hawaii, Connecticut, Massachusetts, and California. Each state had over 44 percent of all households subscribing to broadband service. The bottom five states in residential broadband penetration were Mississippi, South Dakota, North

Dakota, Kentucky and Louisiana with each state having less than 22 percent of households subscribing to broadband service.[32] From these statistics, there can be some conclusions drawn. The states with the top broadband penetration have high population densities (significantly above the 79.6 persons/sq mile average of the U.S.), and each one has median household incomes which are above the national median of $43,318. All the states with the worst broadband penetration have a lower household income median than the national median and their population densities are below the national average with the exception of Kentucky and Louisiana.[33]

### 1. DSL

DSL service in the United States is growing rapidly. In 2003 DSL ranked second to cable companies as the top provider of broadband access with a 28 percent share of the market compared to cable’s 67 percent share. In 2005 the rate of growth of DSL was nearly twice that of cable broadband. Those numbers have continued to close each other and as of the third quarter of 2006, DSL had closed the gap to within five and a half million subscribers of cable broadband. DSL service was provided to 44.7 percent of the broadband subscribers while cable companies provided 55.3 percent.[34] DSL's price advantage seems responsible for its faster growth rate.

Speeds can vary widely depending on the version of DSL, the quality of the copper wire used, and the distance from the telephone company’s central hub (up to 18,000 ft). The average download speed of a DSL connection in the U.S. is 1.5 Mbps. Approximately 14 percent of DSL lines are capable of 2.5 Mbps or more in the fastest direction.[35] This is usually over a version called Asynchronous DSL (ADSL) which has faster download speeds than upload speeds. Although the typical speed is 1.5 Mbps, DSL is highly dependent upon the distance the user is from the central office. For businesses, DSL is often inadequate due to the asymmetric nature of most DSL versions

[32] Leichtman Research Group.

[33] U.S. Census Bureau, January 2007.

[34] Leichtman Research Group, Inc. 3Q 2006.

[35] Ibid.

being supported by the telephone companies. Businesses tend to be more symmetric in their Internet use while home users are more asymmetric.

There are many DSL providers in the United States, but the majority of DSL coverage is provided by AT&T and Verizon. By the end of 2006, AT&T, Verizon, BellSouth (now part of AT&T) and Qwest accounted for nearly 90% of the DSL lines. This effectively has set up regional duopolies in the DSL market across the United States. Even with the duopoly, competition has lowered the price of DSL significantly since 1999. DSL competition has even provided low enough prices that the number of DSL subscribers is expected to exceed cable subscribers by early 2008.

| **Provider Name** | **Download Speed (Max.)** | **Upload Speed (Max.)** | **Price per Month** | **DSL Type** | **Plan Name** | **Notes** |
|---|---|---|---|---|---|---|
| Verizon | 3 Mbps | 512 Kbps | $29.99 | ADSL | Power Plan | 1 yr contract |
| AT&T | 6 Mbps | 768 Kbps | $34.99 | ADSL | Elite DSL | No contract |
| Covad | 1.5 Mbps | 1.5 Mbps | $269.95 | SDSL | TeleSpeed | 1 yr contract |
| DSL.net | 1.5 Mbps | 1.5 Mbps | $199.95 | SDSL | 1500 Plan | 1 yr contract |
| Speakeasy | 6 Mbps | 768 Kbps | $109.95 | ADSL | Line-share Select PLUS | |

Table 9. Premium Residential DSL Providers and Service Information (information gathered from company websites).

### 2. Cable Modems

Similar in concept to telephone lines, cable television lines can be used to carry broadband signals in addition to cable TV channels with the use of filters since the TV signals and the broadband Internet signals operate on separate frequencies. Unlike DSL, cable broadband capacity and speed is not limited by its distance from the central hub. Its performance, however, is limited by the number of users that simultaneously use the network to download and upload data. With the addition of filters and some updated infrastructure, broadband access can be provided by cable television providers anywhere.

Cable television has been able to grow rather quickly in the United States because of the lack of regulation put on it by the FCC. The cable networks are privately owned and closed systems. Cable companies have never been required to share their networks with competitors. This has enabled the larger cable companies such as Comcast and Time Warner to grow quickly and remain highly profitable due to no other regional competitors that DSL providers had to deal with in the beginning roll out of DSL in the late 1990s and early 2000s.

Cable broadband lines on average provide higher speeds than what DSL lines can provide. As of 2006, 85 percent of cable broadband lines had speeds over 2.5 Mbps.[36] Cable is more common among higher income subscribers in the United States while DSL is more common among the lower to middle-class. Similar to the DSL market, the cable broadband market is a regional duopoly. Comcast and Time Warner account for over 50% of the cable broadband market in 2006. This has prevented competition from other cable companies which may have limited price competition among the cable broadband providers. Cable companies have, however, started to become more aggressive in their broadband pricing since the FCC recently ruled to allow telephone companies to enter into the digital television market.

Another advantage that the cable companies have been able to exploit is their ability to offer the "triple-play" package to its customers. Bundling voice, high-speed Internet and digital TV all in one package for customers has made cable a popular choice among broadband subscribers. The quality and ease of having all services offered by one company and billed on one bill has given cable companies a head start on the telecommunication companies which used to be able to only offer voice and high-speed Internet. This situation is changing now since the telecommunication companies are now rolling out digital television as part of their service, but the quality and quantity of television channels depends on the wire being used and most often has been relegated to the new fiber networks beginning to be installed throughout the United States in FTTH and FTTC projects.

[36] Leichtman Research Group, Inc. 2Q 2006.

| Provider Name | Download Speed (Max.) | Upload Speed (Max.) | Price per Month | Modem Price | Notes |
|---|---|---|---|---|---|
| Comcast | 8 Mbps | 768 Kbps | $67.95 | $99 or $3/month | No contract |
| Cox | 12 Mbps | 1 Mbps | $56.95 | $79 | No contract. Must bundle broadband with other services |
| Road Runner | 7 Mbps | 512 Mbps | $59.95 | $3/month | 1 yr contract |
| Charter | 10 Mbps | 1 Mbps | $69.99 | $3/month | No contract. Price is $10 cheaper if cable TV is ordered as well |

Table 10. Premium Residential Cable Broadband Plans in the United States (information gathered through company websites).

### 3. Fiber Optics

Fiber provides the fastest broadband access as well as most capacity of any other technology. Fiber optics consists of thin glass fibers that are capable of transporting light. There is no electricity involved while the light is being transferred through the glass fiber. The light signals are then decoded at the end of the fiber by a special optic decoder/encoder. This allows for the light signal to be transformed into bits, a series of ones and zeros, which can then be used to encode data that travels on the Internet.

The advantage of fiber optics over all other medium in the broadband arena is that it provides high capacity over a small cross section. Fiber optic signals also do not attenuate much compared with signals that pass over copper lines or through the air. Light does not produce excess heat and the glass fibers do not corrode. These features make fiber optics the best choice when deciding on what broadband access medium to choose.

Despite plans during the mid-1990s to deploy fiber to over 12 million homes, by mid-2006 only four million home had the potential of being connected to a FTTH network yet only a mere 670,000 had become subscribers. Broadband service offered over fiber optics is slowly becoming a reality in the United States. The 670,000 FTTH

subscribers in the United States account approximately for 0.6 percent of homes in the United States. 81 percent of those subscribers belong to Verizon Communications deployed to 730 communities.[37] The remaining 19 percent belong to independent telecommunication companies and municipalities. AT&T, which dominates the Midwest, Southeast and Southwest markets, is also laying fiber, although at a much slower rate. AT&T plans to stop the work after spending about $10 billion (the estimated cost of bringing fiber close to about 10 million U.S. homes and offices) and then examine whether further investment is justified.[38]

Fiber is an expensive choice for telecommunications and cable companies to invest in. Although the capacity and speed of fiber is far and above better than anything the telecommunications and cable companies have now, the return on investment from installing fiber infrastructure is many years down the road. After the Internet boom of the late 1990s and then its bust in mid-2000, telecommunication companies have struggled to stay profitable and have been apprehensive in investing in more network improvements such as FTTH or FTTC because of the lack of venture capital and the shrinking of marginal profits. Due to these problems, fiber being used as a medium to provide broadband access at home has been pushed to the back of the line while DSL and cable have seen a return of profitability. The telecommunications and cable companies' bottom line seems to be a significant driver in why FTTH or FTTC has not taken off the way it has in other countries such as Japan or South Korea.

AT&T has stated that it plans to bring fiber-to-the-node technology to 19 million homes by 2009 at a cost of $4.6 billion.[39] Verizon embarked on a seven-year project in 2004 to run fiber by 18 million homes in the areas where it offers phone service. As of the end of 2006 Verizon's fiber network already has passed more than six million homes. Verizon's costs for installing FTTH have dropped 40 percent since it started its FiOS (fiber-optic services) network, and it expects to generate profits from the fiber network in its fourth year of operation (2008). Even with declining installation prices for FTTH, Verizon is still spending roughly four times as much as AT&T does using FTTN

[37] Gubbins, p. 1.

[38] Bleha, p. 3.

[39] Grant, p. 1.

technology to lay fiber past the same number of homes. Verizon also has to maintain two different networks in the same area until the FTTH reaches 100 percent penetration. This is an expense that AT&T does not have to worry about since its FTTN networks still interface with the copper wires that provide the broadband connections to the "last-mile."

Verizon and AT&T are the main competitors in the fiber broadband market right now. In order to increase fiber's penetration in the residential areas, these two telecommunications companies have to be willing to spend a lot now to reap the benefits of the state-of-the-art network five to ten years down the road. Verizon's $23 billion commitment to rewire copper connected homes with fiber by 2010 is a great start, but investors are worried the new network may over tax Verizon's profitability.[40] Fiber networks also pose a threat to the telecommunications companies and cable companies in that the lucrative local phone service as well as cable TV service are threatened by high capacity fiber lines. Fiber is able to provide higher quality digital video than traditional cable TV lines and the advent of movie downloads and video clips over the Internet threaten cable TV's existence. Also, VoIP service which is very reliable and inexpensive to use over fiber lines may eliminate the need for local phone lines. Telecommunication and cable TV companies have to weigh the positives versus the negatives on deciding whether to replace their old infrastructure with fiber.

[40]McLean, p. 1.

| Provider Name | Download Speed (Max.) | Upload Speed (Max.) | Price per Month | Modem Price | Notes |
|---|---|---|---|---|---|
| Verizon FiOS | 30 Mbps | 5 Mbps | $179.95 | $3/month | 1 yr contract. FTTH |
| AT&T U-verse | 25 Mbps-only 6 Mbps is set aside for Internet | 768 Kbps | $119 | Included in the monthly charge | FTTN and VDSL. Internet access is no faster than AT&T DSL. Added bandwidth is for HD video only. |
| Cogent | 1000 Mbps | Dependent on contract | Various | Varies | Businesses only |
| Yipes | 10 Gbps | 10 Gbps | On an individual basis | Varies | Businesses only |

Table 11. United States' Fiber Broadband Services (information gathered from company websites).

#### 4. WiFi

The range of frequencies that the 802.11 standard operates on are the 2.4 GHz and 5 GHz bands which are license-free in the United States and in many other countries around the world. This standard has expanded broadband access to many more customers than what was previously available. Home broadband subscribers often set up their own wireless broadband networks in their homes. A recent report by Pew Internet estimated that 19 percent of home Internet users have wireless networks set up at home.[41] This is done through the use of an 802.11x router or access point that is hooked up to the wired broadband line that feeds into the home (e.g., DSL, cable, fiber, etc.). This same technique is being used in many other areas outside the home such as coffee shops, malls, airports.

WiFi can provide up to 54 Mbps service using 802.11a/g although the typical throughput is around 25 Mbps. A newer standard, 802.11n, which has not yet been approved, is capable of up to 540 Mbps with a typical throughput of 200 Mbps. These

[41] Horrigan, "Wireless Internet Access," p. 2.

rates are very appealing to broadband customers in bridging the broadband divide. The only problem is that WiFi broadband is limited in its coverage area and it has many QOS issues that remain to be dealt with.

WiFi broadband is contingent upon having some type of backhaul that connects to the access point so a connection to the Internet can be made. This means a WiFi connection cannot be put wherever a company pleases. In this sense, it does not provide a solution for bridging the digital divide, but it is a step in the right direction. Although the theoretical speeds of WiFi are a lot higher than what most DSL or cable providers can offer, the speed and quality of service is dependent upon the connection that is hooked up to the access point. If that access point only has a 6 Mbps backhaul, then the service offered on the WiFi side can only be up to 6Mbps as long as there is not more than one user and all conditions are set up for ultimate proficiency. This, however, is never the case. WiFi is inherently multi-use and it cannot penetrate physical obstacles very well. The more users that are served by one access point, the lower the average throughput is and the higher the likelihood that overall QOS will diminish.

Most WiFi services offered by broadband providers in the United States include monthly subscriptions around $2.00 a month as long as the customer also subscribes to the high-speed wired broadband service offered by the same company. AT&T for instance offers its WiFi service provided at numerous “hot-spots” all over the country such as McDonalds, Barnes and Noble book stores, The UPS stores, Avis car rental agencies and various airports for $1.99 a month for unlimited access. Another is T-Mobile which offers its unlimited WiFi service for $39.99 per month. The price is more expensive due to T-Mobile not offering wired broadband services which could subsidize lower monthly prices like AT&T does. T-Mobile offers its service to 8,307 locations around the country as well as 23,023 roaming locations in 22 countries.[42]

Where WiFi is making a significant impact in providing broadband access is through privately financed WiFi networks being put up in cities across the country that offer free or deeply discounted basic service to broadband users. Cities such as Philadelphia, Mountain View, Atlanta, Baltimore, Cleveland, Las Vegas, Lexington, Ky.,

[42] T-Mobile’s website www.hotspot.t-mobile.com/ accessed February 26, 2007.

Los Angeles, San Francisco and Seattle all have or are in the process of building public WiFi networks that make use of city infrastructure such as light posts, city buildings, and city-owned emergency radio towers to provide the cities' residents with subsidized broadband service. In Philadelphia for instance, Earthlink set up a public WiFi network which gives all of the city's residents WiFi broadband service for $17.95 a month. Since the WiFi coverage is nearly 100% throughout the city, a resident can access the Internet using a broadband WiFi connection anywhere in the city. The ubiquity of broadband access is very attractive.

There are some detractors, however. The heated battle is between the municipalities wishing to use tax dollars to fund the building of public WiFi networks against the telecommunications industry which see such efforts as a threat to private businesses. Telecommunications companies such as Verizon and AT&T are spending millions of dollars on lobbyist who are trying to convince state and local legislatures to ban municipal WiFi networks across the country. The effort is definitely slowing down the mass building of public WiFi networks, but it is also educating the residents of the cities in question on the benefits of having low-priced access to broadband that might not be possible if the municipality does not step in and build the WiFi network itself.

### 5. Satellite

Satellite broadband service is still an expensive alternative to wired broadband services in the United States. Satellite broadband access is available to every home or business in the United States as long as there is a view of the southern sky. As long as there are no physical barriers that do not obstruct the satellite dish's view of the southern sky, then a satellite signal can be transmitted. Satellite broadband service was thought to be the answer to the country's broadband penetration problem, but due to its expense and limited capabilities such as speed and download limits, it never has held greater than a 10 percent share in the broadband market in the United States.

The first satellite service that provided two-way broadband service was Starband Communications. On November 6, 2000, Starband Communications began to provide

Internet service for the home offering 500 Kbps downstream and 150 Kbps upstream.[43] Soon after in December of that same year, Hughes started its two-way broadband service as well offering download speeds of 400 Kbps and upload speeds of 125 Kbps. As of 2007 the speed of satellite broadband has increased slightly since the beginnings in 2000. Satellite providers can offer speeds upwards of 3Mbps for downloading and the 1.5 Mbps for uploading, but these service plans tend to be expensive.

| **Provider Name** | **Download Speed** | **Upload Speed** | **Price per Month** | **Equipment Price** | **Installation Price** | **Notes** |
|---|---|---|---|---|---|---|
| Hughes Net | 700 Kbps | 128 Kbps | $60 | $300 | $200 | Three different plans: Home, Pro, and ProPlus |
| Wild Blue | 512 Kbps | 128 Kbps | $50 | $299 | $180 | Three different plans: Value, Select and Pro packages |
| VSAT Systems | 512 Kbps | 64 Kbps | $79 | $1,499 | $300 | More of a commercial provider. Has service all the way up to 3.07 Mbps/1.5Mbps but is $1000/month |
| Starband Communications | 512 Kbps | 128 Kbps | $50 | $300 | Included with 12 month contract | Two different plans: Pro and Ultimate |

Table 12. A Partial Listing of Satellite Broadband Home Providers in the United States (information gathered through company websites).

43 Gilroy, p. 3.

For rural businesses that do not have access to broadband, satellite is an alternative that provides enough bandwidth for point-of-sales and minimum Internet browsing abilities. Satellite was touted as the next technology that would bridge the digital divide, but it has not lived up to its billing. Satellite broadband is a niche service which can offer limited broadband services. The physical limitations on speed and data rate using satellites are difficult to overcome while at the same time maintaining prices which are affordable to Internet users.

### 6. Cellular

Cellular broadband plans are expensive and have limited coverage. The spottiness of cell phone coverage in the United States also affects the cellular broadband coverage as well. Verizon Wireless, Sprint PCS and Cingular (now AT&T) are the three largest cellular broadband providers in the United States. Verizon and Sprint offer cellular broadband access through the use of EV-DO Rev A/CDMA technology while Cingular offers it through the HSDPA/GSM technology.

One quarter of the United States' Internet users have a cell phone that can access the Internet.[44] Cellular broadband access is very limited, though. All of the three providers listed in the table below require some type of contract, have "fair use" restrictions on what type of data can be downloaded and uploaded, and also do not permit the cellular broadband connection to be used as the primary connection to the Internet. A lot of the cheaper alternate plans offered by these three cellular phone companies limit the amount of data transfers per month as well. For a person looking for a fast and reliable broadband connection out in the rural areas of the country, the cellular broadband technology cannot fill in for an alternate broadband provider.

[44] Horrigan, "Wireless Internet Access," p. 3.

| Provider Name | Download Speed | Upload Speed | Price per Month | Technology | Notes |
|---|---|---|---|---|---|
| Verizon | 741 Kbps, peak of 1 Mbps | 132 Kbps | $79.99 | CDMA/EV-DO Rev A | $59.99/month for existing voice customers. 2 yr contract |
| Sprint PCS | 1.01 Mbps peak of 1.28 Mbps | 337 Kbps | $80.00 | CDMA/EV-DO Rev A | 2 yr contract |
| T-Mobile | 274 Kbps | 8 Kbps | $49.99 | GPRS | EDGE network available in limited areas as well |
| Cingular | 900 Kbps | 100 Kbps | $79.00 | HSDPA/GSM | 1 yr contract |

Table 13. Unlimited Cellular Broadband Plans in the United States (From PCWorld.com).

Cellular broadband use in the United States is growing, but it is still far from becoming a substitute for regular broadband service. It offers great portability as long as the user stays within the coverage area of the cell provider, but these cells do not provide blanket coverage everywhere in the United States yet. Rural coverage is especially sparse and the costs and speed limitations prevent cellular users from using the broadband service exclusively as their only broadband access.

## C. GROWTH AND SUPPLY

Broadband growth has been steady but not explosive in the United States since 2003, and the rate of improvement has left many Internet consumers frustrated. Even with almost 60 percent of Internet users connecting using broadband connections, competition is still lacking. DSL providers like AT&T and Verizon do have a price advantage over cable, but cable broadband providers find no need to enter a price war with DSL because it views itself as a premium service which DSL cannot provide.

The United States is ranked number three in the OECD in cable modem broadband subscribers with 9.8 subscribers per 100 inhabitants just behind Canada (11.5) and The Netherlands (11.1). The United States' DSL penetration does not rank nearly as high, ranking number 20 in the OECD at 8.0 subscribers per 100 inhabitants which is below the average of 9.7 subscribers per 100 inhabitants for all OECD countries. These

statistics indicate that the United States does have an adequate cable network but its DSL penetration is still far behind.

The rate at which new Internet users adopt broadband as well as current Internet users switching over to broadband service is what will drive the demand of broadband services. Broadband supply is becoming more of an issue now because of the demand of the people in being connected to the Internet and their increased dependence of being connected to businesses, governments, schools and social communities. Broadband penetration is being fueled in part by this requirement to be "connected." The broadband providers are trying to meet the needs as best as they can in the United States, but economics and limited leadership from the federal and state governments have delayed or prevented full scale deployment of their networks throughout the country.

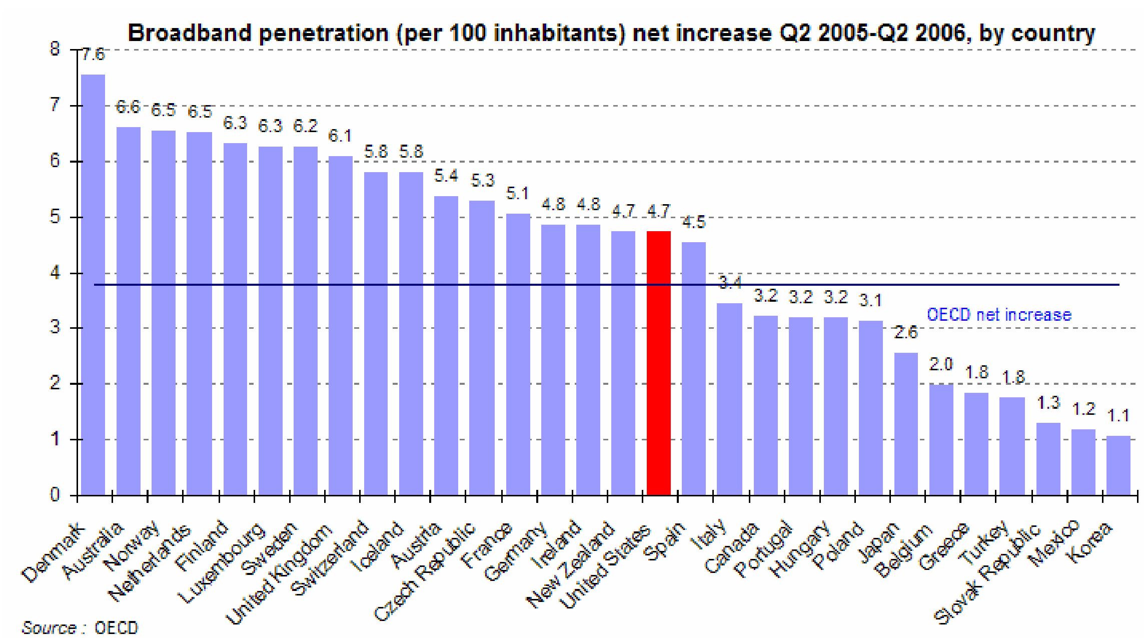


Table 14. Broadband penetration (per 100 inhabitants) net increase Q2 2005-Q2 2006 by country (From OECD).

Relating the growth of broadband access to its supply can offer insights into whether there truly is a broadband distribution problem in the United States. "US broadband penetration among active Internet users grew to 78.45% in December 2006. Narrowband users connecting at 56Kbps or less now comprise 21.55% of active Internet

users, down 0.77 percentage points from 22.32% in November 2006."[45] The number of Americans who have broadband at home has jumped from 60 million in March 2005 to 84 million in March 2006 – a leap of 40%.[46] This is a substantial increase in the rate of broadband adoption compared with the previous year. As of March 2006, 42 percent of all American adults had high-speed Internet connections at home in the United States. In March 2005, that number was only 30 percent.[47] Many new Internet users are now subscribing directly to broadband services first instead of narrowband services first because of added quality of service and lower prices that broadband services have been reaching in the past few years.

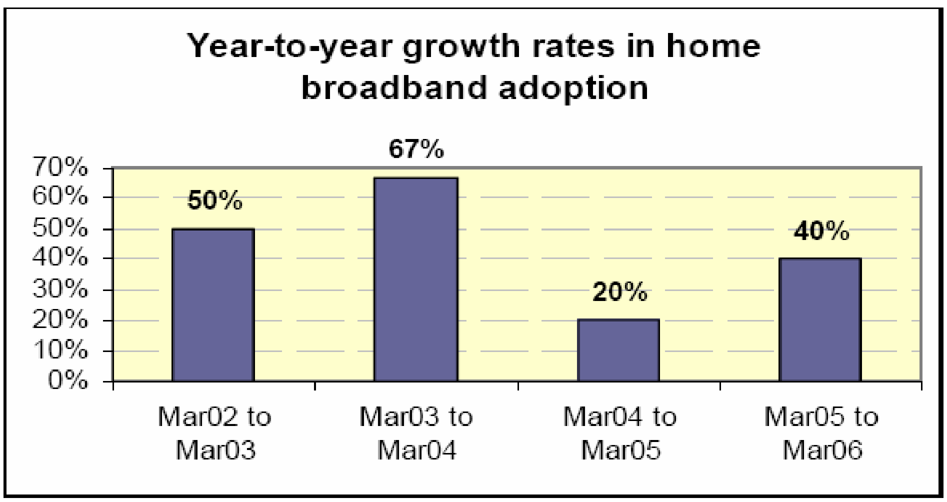


Figure 9. Year-to-year growth rates in home broadband adoption in the United States (From Pew Internet & American Life Project).

[45] WebSiteOptimization.com, January 22, 2007.

[46] Horrigan, p. 2.

[47] Horrigan, "Home Broadband Adoption 2006," p. 1.

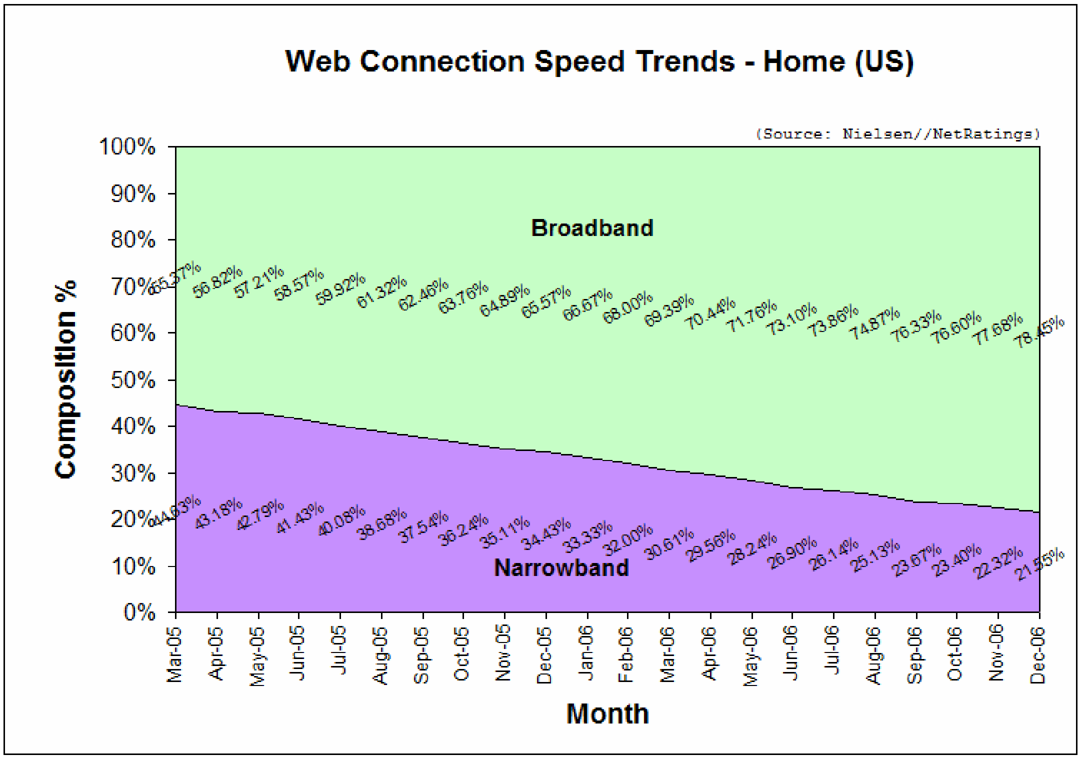


Figure 10. United States' Web Connection Speed Trends-Home (From Nielsen/NetRatings and www.websiteoptimization.com).

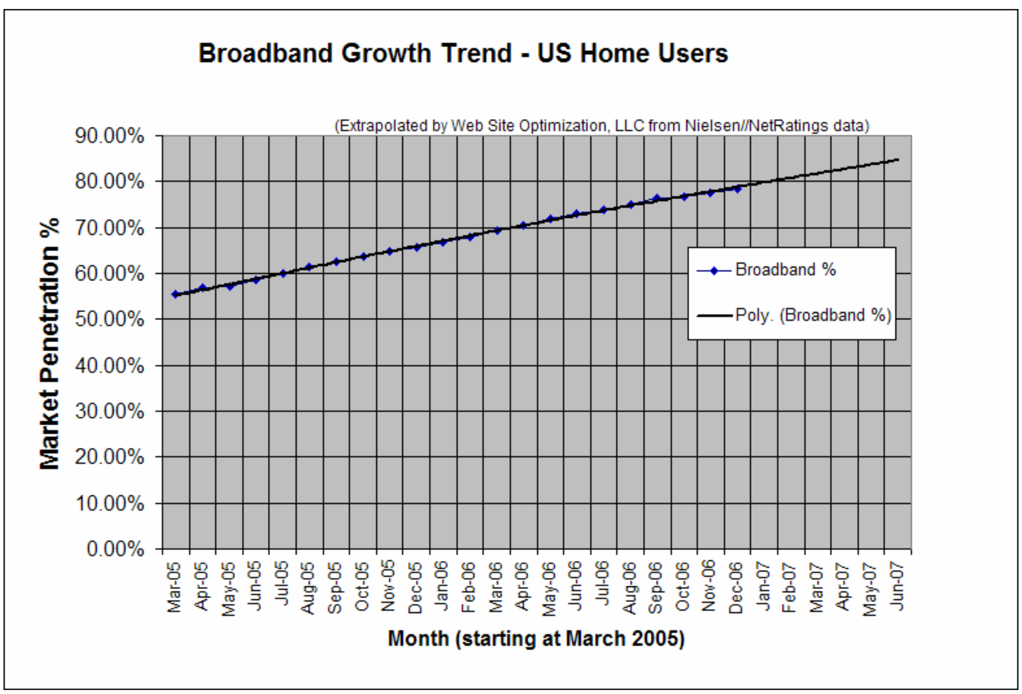


Figure 11. Broadband Growth Trend – US Home Users (From Nielsen/NetRatings and www.websiteoptimization.com).

According to the OECD, the United States has the largest total number of broadband subscribers in the world at 57 million[48]. This represents approximately 31% of all broadband connections in the world. The closest country in terms of broadband subscribers is China at 37.5 million subscribers, but China is quickly closing the gap. According to Ovum, an analyst and consulting company, China is expected to surpass the United States in broadband subscribers by 2007 with 79 million. By 2010, China will have an estimated 139 million broadband subscribers. As a percentage of the population the United States ranks number 12 in the world when the amount of broadband subscribers per 100 inhabitants is measured. Meanwhile, Japan ranks right below the United States as number 13.[49] China's considerable population drops its broadband penetration to only 2.9 subscribers per 100 inhabitants. This would rank it number 28 on the 2006 OECD Broadband Report (see Appendix A) if China were a member of the OECD.[50]

| Year | Usage (in millions) | Increase (in millions) |
|---|---:|---:|
| 2002 | 18.9 | n/a |
| 2003 | 26.2 | 7.3 |
| 2004 | 33.5 | 7.3 |
| 2005 | 41.0 | 7.5 |
| 2006 | 48.1 | 7.1 |
| 2007 | 55.2 | 7.1 |
| 2008 | 61.5 | 6.3 |

Table 15. Projected U.S. Broadband usage, At-Home, 2002-2008 (From Yankee Group, August 2003).

48 OECD reports 57 million broadband subscribers as of 2005, updated numbers from the FCC report 64.6 million residential and business subscribers in the United States as of June 30, 2006. The OECD has not yet come out with statistics on 2006 in order to compare.

49 OCED Broadband Statistics to June 2006.

50 "digital.life," p. 25.

| Economy | Total fixed broadband Subscribers (000s) | Penetration (per 100 Inhabitants) | As % of Internet subscribers | Price in USD per 100 kbit/s |
|---|---|---|---|---|
| 1. United States | 49'391.1 | 16.6 | 73.9 | $0.49 |
| 2. China | 37'504.0 | 2.9 | 51.2 | $1.43 |
| 3. Japan | 22'365.1 | 17.5 | 66.0 | $0.07 |
| 4. Korea (Rep.) | 12'190.7 | 25.2 | 100.0 | $0.08 |
| 5. Germany | 10'686.6 | 12.9 | 53.4 | $0.51 |
| 6. United Kingdom | 9'539.9 | 16.0 | 63.1 | $0.63 |
| 7. France | 9'465.6 | 15.6 | 75.3 | $0.36 |
| 8. Italy | 6'820.0 | 11.7 | 38.5 | $0.30 |
| 9. Canada | 6'706.7 | 20.8 | 90.1 | $1.01 |
| 10. Spain | 4'994.3 | 11.7 | 90.0 | $4.84 |
| 11. Taiwan, China | 4'602.2 | 20.1 | 61.2 | $0.18 |
| 12. Netherlands | 4'100.0 | 25.2 | 58.6 | $0.14 |
| 13. Brazil | 3'304.0 | 1.8 | 41.8 | $1.08 |
| 14. Mexico | 2'304.5 | 2.2 | 58.0 | $6.25 |
| 15. Australia | 2'102.9 | 10.4 | 35.2 | $3.45 |
| 16. Belgium | 1'974.8 | 19.1 | 90.3 | $1.21 |
| 17. Sweden | 1'838.0 | 20.3 | 55.8 | $0.23 |
| 18. Switzerland | 1'725.4 | 23.1 | 71.6 | $1.58 |
| 19. Hong Kong, China | 1'659.1 | 23.6 | 62.8 | $0.83 |
| 20. Turkey | 1'589.8 | 2.2 | 70.6 | $10.52 |
| WORLD | 215'477.7 | 3.3 | 56.2 | $72.20 |

Note: «Broadband» is ≧ 256 kbit/s in one or both directions

Table 16. Top 20 Economies as of December 31, 2005 (From digital.life, ITU Internet Report 2006).

Rural growth in the United States is not growing as fast as the urban and suburban markets. Long distances between users and the lack of wired infrastructure make broadband service expensive to provide and not very profitable for the telephone or cable companies. In the past few years, there have been slight improvements in the penetration of broadband services to the rural communities. The pace of adoption in rural areas was around 39 percent between 2005 and 2006.[51] By the end of 2005, 24 percent of rural Americans had broadband connections at home, up from nine percent at the end of 2003.

[51] Horrigan, "Home Broadband Adoption 2006," p. 1.

In comparison, 36% of all Americans had broadband Internet access at home at the end of 2005, up from 22 percent at the end of 2003.[52]

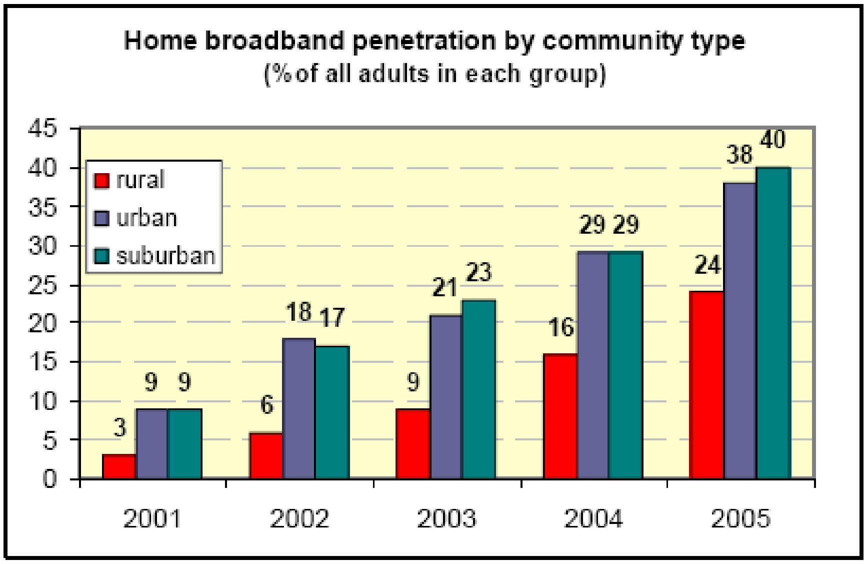


Figure 12. Broadband penetration by community type (From Pew Internet & American Life Project).

[52] "Rural Broadband Internet Use," p. 8.

| How Broadband is Spreading Through the Population<br>Changes in the percentage of each group who have broadband connections at home | % with broadband at home (2005) | % with broadband at home (2006) | Percentage point increase | Percentage increase |
|---|---|---|---|---|
| **Gender** | | | | |
| Male | 31% | 45% | 14% | 45% |
| Female | 27 | 38 | 11 | 41 |
| **Age** | | | | |
| 18-29 | 38 | 55 | 17 | 45 |
| 30-49 | 36 | 50 | 14 | 39 |
| 50-64 | 27 | 38 | 11 | 41 |
| 65+ | 8 | 13 | 5 | 63 |
| **Race / ethnicity** | | | | |
| White (not Hispanic) | 31 | 42 | 11 | 35 |
| Black (not Hispanic) | 14 | 31 | 17 | 121 |
| Hispanic (English speaking) | 28 | 41 | 13 | 46 |
| **Educational attainment** | | | | |
| Less than high school | 10 | 17 | 7 | 70 |
| High school grad | 20 | 31 | 11 | 55 |
| Some college | 35 | 47 | 12 | 34 |
| College + | 47 | 62 | 15 | 32 |
| **Household income** | | | | |
| Under $30K | 15 | 21 | 6 | 40 |
| $30K-50K | 27 | 43 | 16 | 59 |
| $50K-$75K | 35 | 48 | 13 | 37 |
| Over $75K | 57 | 68 | 9 | 19 |
| **Community type** | | | | |
| Urban | 31 | 44 | 13 | 42 |
| Suburban | 33 | 46 | 13 | 39 |
| Rural | 18 | 25 | 7 | 39 |

Table 17. How broadband is spreading through the population (From Pew Internet & American Life Project)[53].

Despite President Bush's promise of universal access to broadband by 2007 there are still areas within the US that have little or no coverage, according to DSLReports.com. A GAO survey conducted in 2005 found that 28% (about 30 million) of American households have adopted, or have purchased broadband service. The same survey also found that 30% of the households subscribe to some sort of narrowband Internet service, and 41% did not access the Internet. 61 percent of home broadband

[53] 2005 data comes from the Pew Internet Project's combined January-March tracking survey of 4,402 adults; 1,265 were home broadband users. 2006 data comes from the Pew Internet Project's February 15 through April 6 survey of 4,001 adults; 1,562 were home broadband users.

users reported that they have access to more than one broadband provider while 25 percent report that they do not have more than one broadband provider as of December 2005.[54]

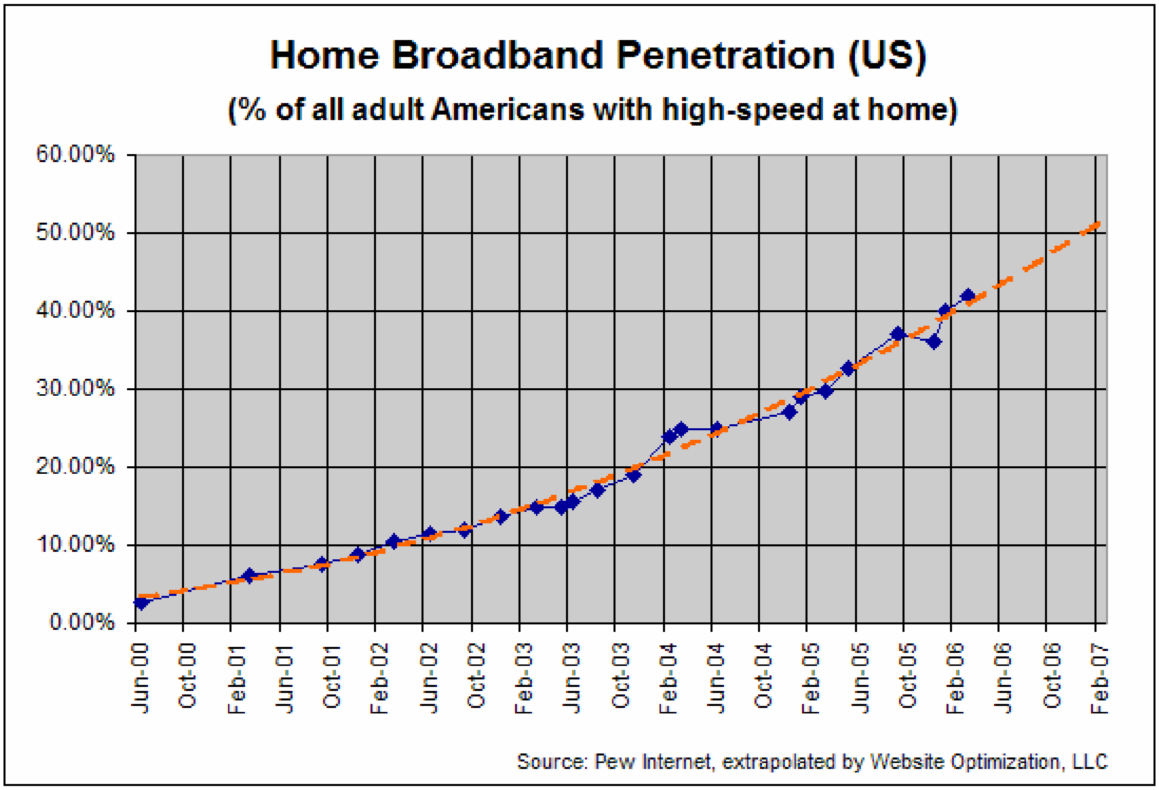


Figure 13. Home Broadband penetration in the US (From Pew Internet & American Life Project).

## D. BROADBAND SPEED

In broadband terms, speed can be defined as the bits per second that data can be transmitted over a medium. The more bits per second that can be transmitted and received by the end user directly reflect on the speed of an Internet connection. The technical term for speed in the broadband context is data rate. In the United States, the four most common mediums that provide broadband connections are DSL, cable modems, fiber optics, and wireless connections.

[54] Horrigan, p. 5.

The interaction of an Internet user can be simplified into two categories: uploading and downloading. Speed can be a misleading measurement for broadband service, however. Often is the case that the broadband providers advertise just the download speed for the connections they provide. The very nature of the WWW consists of a server sending images, audio clips, and streaming video to an Internet browser running on a computer. These actions consists of mainly downloading the data from a server located on the Internet as well as sending minimal requests messages to the server for specific information (i.e.-web pages). The request messages do not contain much data and can be sent quickly even with a restricted upload speed. This difference in the uploading and downloading speeds is called an asymmetric Internet access, where usually the downloading is much faster than the uploading speed. When the WWW was first introduced, the advertising of only the download speed was sufficient since there was not much uploading of material to the servers by the Internet users. Most of the uploading was completed at the sever locations by people running the websites. Most times, broadband providers also state the speed offered as their maximum speed available. This maximum speed is never guaranteed by the providers and only a small percentage of subscribers actually receive the maximum speed advertised by the provider.

When the WWW became more interactive and more users began to express themselves through the use of the Internet, uploading speeds started to become an important part of the WWW experience. With the advent of digital pictures, video clips, and multimedia documents, Internet users started to share their data with other Internet users via email and the WWW. Home users became more symmetric in their use of the Internet, typically having a 3:1 or 4:1 ratio of downstream to upstream traffic, versus the 8:1 ratio that is common among the ILEC's (Incumbent Local Exchange Carrier) broadband services.[55] The Internet has become a place for self expression through the uploading of this multimedia data which has increased the need for higher upload speeds.

[55] Ferguson, p. 66.

## E. COSTS

The price per bit in the United States is higher than many of the countries ranked ahead of it in the OECD Broadband report. Broadband access prices are trending slowly downward, but prices are still much higher in the United States than in many of the countries that lead the world in broadband use. The International Telecommunication Union ranked the United States as number eight in the world for the price of broadband service at the end of 2005 at $0.49 per 100 Kbps. This is a great improvement from 2002 when the price per 100 Kbps was $3.53 while Japan's price was only $0.09, but even as 2007 has started, the United States still has not met the goal that President Bush envisioned in 2004 when he stated that he would like to see universal and affordable broadband access in the United States by 2007.

| *Economy* | *Company* | *Technology* | *Speed (kbit/s)* | *Price per month (USD)* | *Price per 100 kbit/s* | *Change, 2003-04* |
|---|---|---|---|---|---|---|
| Japan | KDDI | DSL | 47'000 | 25.85 | 0.06 | -44.1% |
| Korea (Rep.) | Hanaro | DSL | 20'000 | 47.86 | 0.24 | -4.0% |
| Sweden | Bredbandsbolaget | FTTH/DSL | 24'000 | 58.63 | 0.24 | -97.4% |
| Taiwan, China | Chunghwa | DSL | 8'000 | 35.30 | 0.44 | n.a. |
| Hong Kong, China | Netvigator | DSL | 6'000 | 51.03 | 0.85 | -33.2% |
| Canada | Bell | DSL | 3'000 | 34.05 | 1.13 | -66.6% |
| Belgium | Belgacom | DSL | 3'300 | 48.40 | 1.47 | 19.6% |
| Singapore | StarHub | Cable | 3'000 | 46.50 | 1.55 | -31.3% |
| Switzerland | SwissCom | DSL | 2'400 | 77.88 | 3.24 | -73.3% |
| USA | Comcast | Cable | 3'000 | 52.99 | 1.77 | -50.0% |
| Netherlands | Wanadoo | DSL | 1'120 | 42.35 | 3.78 | 5.5% |
| Finland | Sonera | DSL | 2'048 | 82.28 | 4.02 | -53.6% |
| Iceland | Vodafone | DSL | 500 | 21.00 | 4.20 | -37.1% |
| Denmark | Tele2 | DSL | 2'048 | 86.32 | 4.21 | -32.1% |
| Norway | Tele2 | DSL | 1'024 | 62.95 | 6.15 | -11.0% |
| **Average** | | | **8'429** | **51.56** | **2.22** | **-36.3%** |
| **Best practice (top 20%)** | | | **30'333** | **44.12** | **0.18** | **-48.5%** |

Table 18. Top 15 broadband economies, July 2004 ranked by USD per 100 Kbps (ITU September 2004).

Taxes and governmental fees typically do not drastically affect broadband prices in the United States. Cable and satellite broadband providers do not have to pay any special fees or taxes, but telephone companies have to provide for something known as the Universal Service Fund. The Universal Service Fund, which is funded primarily by

long distance phone service providers, local phone companies and wireless companies, does provide subsidies for low-income customers, high-cost areas, and rural health care providers, schools and libraries. As local and long distance phone companies lose more subscribers to VoIP subscribers which do not have to fun the Universal Service Fund, those same companies end up having to pay more to the fund in order to properly maintain the subsidies.

Overall, the average price of monthly broadband service has dropped from $39 in February 2004 to $36 in December 2005.[56] The average DSL monthly bill in December of 2005 was approximately 32 dollars while cable modem users paid on average 41 dollars monthly. This can be compared to dial-up narrowband service which averages approximately 18 dollars as of December 2005. These rates are for stand-alone services, however, and often are lower when a customer buys other services through the same company such as voice or TV plans. Cable and telecommunications companies often offer its subscribers substantial discounts for its broadband service is other services are "bundled" such as TV and voice plans. Although DSL is cheaper and growing faster than cable broadband use, cable is still growing strongly enough that the industry does not have to engage in a price war to lure new customers.

Franchising in the telecommunications industry is costing consumers in the United States excessive fees and increased charges on their broadband service. One way to control the telecommunications networks in the local municipalities is to offer something called a franchise. By setting up a franchise, the municipality offers the right to a telecommunications or cable company to exclusively offer its services in the community and bans other competitive providers through law, regulation or other mechanisms of government. Franchises provide the municipality with large amounts of taxes and fees that it can use for its budget which is why they are favored and implemented throughout cities and states in the United States.

Franchising can be thought of as a government monopoly. Franchises are set up in cities throughout the United States and can be very expensive to obtain. Most franchises are owned by incumbents that have been offering their services for years to the

[56] Horrigan, p. 5.

community. New entrants into the telecommunications or cable markets in the municipalities are severely limited in their quest to take over a franchise from an incumbent because of excessive time in manpower for meetings and negotiations with the city and the costs that are put upon the new entrants. It is estimated that the hidden tax on the system design of telecommunication and cable franchises add between 25 and 45 percent costs per subscriber above the infrastructure costs which cannot be capitalized over a period of time.[57]

Another major producer of high-costs for broadband in the United States is the cost of transiting or interconnection. For example, in Hanover, NH the cost to connect an ISP to the Internet backbone runs $400 per Mbps per month. In Frankfurt, Germany the cost to connect to Level 3, a tier one backbone company, for all Central Europe is $12 per Mbps per month.[58] Why the difference? Clearly buying power has something to do with this but also there are factors which go well beyond costs. This pricing is not cost based. It is what the market will bear. And in the current market, smaller broadband providers bear a dramatic price. This often prevents the smaller providers from being able to compete with the incumbent cable or telephone companies which in turn keep prices high.

The transit costs that all broadband providers have to pay to the Tier One backbone providers are something common only in the United States. In Europe for instance, instead of Tier One interfaces, Internet traffic is transited through what is called a NIX (National Internet Exchanges). The NIX provided local intra-country DNS facilities that allow ISPs to have interconnectivity with one another. The NIX concept has expanded to all countries except the United States and is a way to get around paying the exorbitant transit fees charged by the Tier One backbone companies. The NIX enables broadband deployment with low cost interconnections which can be trickled down to the subscribers in way of cheaper broadband rates.

Litigation and lobbying also affect the price of broadband in the United States. The large incumbent telephone and cable companies have very large lobbying firms that

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[57] McGarty, p. 34.

[58] McGarty, p. 26.

work for them in Washington D.C. as well as with state and local governments. These companies are able to take smaller companies to court and keep them in litigation for months or even years before any decision is made by the courts. Both the lobbying and the litigation cost the large incumbents a lot of money that ultimately is passed down to the subscribers. Litigation and lobbyist make it difficult for new providers trying to enter a broadband market. High legal bills and stiff lobbying by the incumbents often causes the new broadband entrants to give up their inquiry of setting up service in a community already serviced by incumbents. In the end, the consumer is charged the higher prices to cover for all the legal wrangling and lobbying that is done.

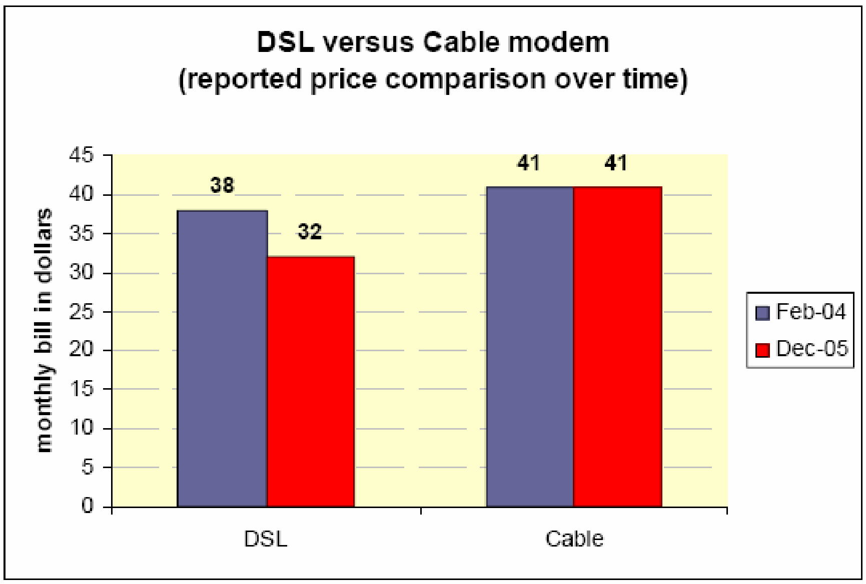


Figure 14. Cost comparison of DSL and Cable modem broadband service over time (From Pew Internet & American Life Project).

| Broadband Service | Average Monthly Price | Time Frame |
|---|---|---|
| All | $36 | December 2005 |
| DSL | $32 | December 2005 |
| Cable Modem | $41 | December 2005 |
| Fiber | $180 | January 2007 |
| Satellite | $60 | January 2006 |

Table 19. Broadband service price in the U.S.

## F. BROADBAND POLICY

Government policy has had a major affect on the deployment of broadband service in the United States. Deployment in rural areas has been facilitated by access to federal universal service fund subsidies and grants and loans from the Rural Utilities Service of the U.S. Department of Agriculture. Local policies regarding wireless tower placement and the ease or difficulty in acquiring a cable TV permit (or “franchise”) affect deployment decisions as well.

The broadband industry is still a young and growing industry in the world. There have been some star performers in policy implementation around the world and there have also been some that have lagged behind or have failed to recognize some important regulation decisions. Future vision is critical in deploying and sustaining a broadband innovation and penetration. The United States has unfortunately started slower than other countries such as South Korea, Japan, and Denmark in implementing useful regulations that promote broadband penetration and use. From the very beginning of the broadband revolution began in the late 1990s, the United States has struggled to provide and expand its broadband penetration because of the endless regulation hurdles which have been created from rules and legislation made before broadband technology ever became popular. Trying to regulate an industry with “old” rules by adapting regulations and laws made for an entirely different industry like telephony has limited the broadband provider’s ability to compete and expand their networks. Patch work regulations and weak policy has led to the United States’ broadband penetration problem it had from the very beginning in the late 1990s.

Policymakers in the United States are starting to turn away from old-world regulatory solutions for the broadband world, and coming down on the side of consumer-driven markets. They are siding with subscriber's choice, rather than industries' preferred business models. It is a sign that the United States is again on the right path towards a vision that could boost its ranking in the world in broadband penetration as well as price. The FCC is moving towards classifying all broadband as an informational service rather than a telecom or cable service. This has allowed the market to work and rather than having government intervene.

From the time DSL was marketed till 2003, there was one glaring disadvantage DSL had to deal with which the cable companies did not and that was governmental regulation. Cable companies meanwhile enjoyed very limited regulation by the FCC. Cable television was categorized as an informational service by the FCC and hence was not subject to the regulations of the telephone companies since their services mainly consisted of voice services. Due to the provisions set up in the 1996 Telecommunications Act, the ILEC had to provide access to their telephone lines (which included DSL capability) to their competitors at wholesale prices instead of retail value. This enabled ISPs and telecommunication startups an easy way of setting up broadband services to customers without having to invest in the expensive infrastructure.

Although the provision was created to promote competition for the penetration of DSL, it actually slowed down the penetration of broadband access as well as limited investment in new telecommunications infrastructure. New entrants into the broadband market were comfortable with not having to build more broadband infrastructure since it already was provided at wholesale prices by the ILECs. The ILECs delayed spending money on new infrastructure because it would only have to be leased out at wholesale price to anyone wanting a piece of the broadband market.

This regulatory hurdle has partially been overcome, though. On February 20, 2003, the FCC voted to continue enforcing local phone companies to lease their networks to long distance rivals at discounted rates, but decided not to enforce the mandate for ILECs to share their new broadband networks at discounted rates.[59] The FCC voted to

[59] Rosenbush, p.1.

lift many of the regulations that gave competitors access to phone lines for broadband service, and then shifted the regulatory burden to the local and state utility commissions which regulate telecommunications at the local and state levels respectively. This has helped reduce the cost of local phone calls due to competition from the influx of companies offering local phone service by leasing telephone lines from the ILECs. It also has provided an incentive for broadband providers to continue building new infrastructure in order to compete with other competitors for new customers. There has been a dramatic increase in DSL subscribership along with faster connection speeds and plummeting prices because of the increased competition. Many state and local utility commission have recognized the damage the FCC's enforcement of the old mandates on the broadband providers and correspondingly have provided less regulations which has boosted broadband competition and increased the building of new broadband infrastructure.

### 1. The Policy Makers

During the 107th Congress, legislative proposals and policy issues centered on two approaches: reducing the legal restrictions and requirements on incumbent telecommunications companies that provide broadband access (the "Tauzin-Dingell" legislation), and providing federal financial assistance, such as grants, loans, or tax credits for broadband deployment in rural and economically disadvantaged areas.[60] On February 20, 2003, the FCC adopted new rules which lift most obligations on incumbent telecommunications companies to provide competitors access to their broadband networks. Then, on March 26, 2004, President Bush endorsed the goal of universal broadband access by 2007. This was followed, on April 26, by the release of an Administration broadband policy endorsing: a ban on broadband taxes, more spectrum for wireless broadband, and standards for broadband over power lines and rights-of-way on federal lands for broadband providers.

Broadband policy in the United States is controlled by the FCC through its authority given by Congress. Often, though, the FCC makes policy changes for anything relating to the telecommunication industry without concern for Congress's advice or

[60] CRS Report to Congress, September 8, 2004. p. 19.

whether the executive branch of the federal government will intervene. The FCC is a governmental agency consisting of five providentially appointed officials whom together form a proxy of all the powers of the government when telecommunications is concerned. The FCC plays the role of the legislative, judicial and executive branches of government all rolled into one commission capable of making laws, judging on mergers, and forming new telecommunications policy.

The FCC has had, since its inception in 1934 with the Communications Act of 1934, multiple and conflicting responsibilities which include the writing of rules to implement policy, the enforcement of those rules, and the adjudication of the disputes that can arise under them. When the Telecommunications Act of 1996 was passed by Congress, many officials in government and in the industry hoped the Act would take away some of the FCC's powers. A decade later in 2006 it seems the FCC is even more powerful than before, and dissatisfied parties have concluded that the FCC has not implemented the Act of 1996 precisely the way it was written which has caused the courts to overturn numerous decisions the FCC made reeking havoc among investors who invested in the telecommunications sector based on rulings the FCC made only to see them overturned shortly thereafter.

Although the FCC is the main regulator of everything related to telecommunications, there are separate state and municipal level telecommunication regulators as well. State level telecommunication regulating committees are known as Public Utilities Commissions (PUC) or Public Service Commissions (PSCs). PSCs and PUCs can make policy that regulate the telecommunications industry within the state as long as it does not interfere with federal decisions or policy established by the FCC. Often PSCs and PUCs levy some sort of tax or fee to fund their version of the federal Universal Service Fund run by the FCC. Along with telecommunications, these commissions also usually regulate other privately-owned utilities such as electric power, water, and transportation companies. The commissions also have regulatory control over a lot of the telecommunication franchises serving regional or local municipalities. Franchise taxes provide a lot of revenue for the state and municipal governments. Municipalities also have some sort of regulating body which look out for the interests of the municipality.

Larger cities like Philadelphia or San Francisco will have separate commissions as well which rule over the telecommunication systems in their cities as well as controlling franchising rights and procedures. These commissions have become more powerful in the last few years as new wireless broadband technology has become a hot topic of discussion among private and public interests within these larger cities.

### 2. Competition and Rates

There has been an increase in competition in the broadband market in the United States. Cable and telephone companies have been going back and forth to sway customers to their broadband service, usually through the use of "triple-play" offerings where TV, telephone and high-speed Internet access is offered by the same provider. The facilities-based competition between the telecommunication companies and the cable companies remained a principal driver behind the increasing broadband growth, affordability and innovation from 2000 to 2005. Before the FCC ruled that the ILECs did have to share access with competitors on the local loop, competition was indirectly created by forcing the incumbent telephone companies to lease their network at wholesale rates to competitors wishing to enter the broadband market.

Recently, as of 2006, the telephone companies and the cable companies have been cutting prices of their broadband services to induce more subscribers to sign up with each of them respectively. After the FCC's vote to lift the unbundling rules in 2003-2004, capital investment in the telecommunication sector has been unleashed by the market-driven approach to broadband. This has stimulated competition as well as started a pricing war between DSL and cable broadband providers. It is a sign that the competition between the cable and telephone broadband providers may be promoting increased broadband penetration to Internet users which may have only connected via narrowband previously. A critical issue for the next five to ten years will be the extent to which the telecommunication companies control the fiber optic network, which will become the backbone of the United States' broadband network, and how that network is regulated. The 2005 and 2006 mega-mergers, including SBC and AT&T, and then AT&T and BellSouth, bring this issue into sharper focus.

### 3. Unbundling of the Local loop

The 1996 Telecommunications Act directed ILECs to lease some of their network capacity to their competitors at wholesale prices. In order to do this, the ILECS were required to "unbundle" their services so that its competitors could make use of them at a cheaper wholesale rate. Unlike other countries where unbundling was required in order to provide competition among broadband providers, mostly DSL providers, the 1996 Telecommunications Act failed in providing enough guidance and leadership in finding the right balance of wholesale pricing with new investment into expanding broadband penetration. Instead of boosting competition and improving broadband distribution, the Act quelled new investment by the local telecommunication companies into improving their existing broadband networks and it failed in motivating them to expand the networks to outlying areas around the country.

What the Act did do was allow hundreds of smaller companies to lease part of the network from the ILECs for wholesale prices. The ILECs had no incentive to make the network better or offer better service to these new companies which were operating on the ILECs' own networks. As cable TV providers became increasingly attracted to the idea of offering broadband service over their networks, some questions were brought up by many of the disadvantaged ILECs that were affected by the Act. Questions such as why cable operators were not subjected to the same rules and regulations as the telephone companies were raised. The telephone companies argued the broadband services the cable operators were providing was the same type of service that they provided over their voice networks. The only difference was the cable modem service was ruled by the FCC to be an information service instead of a voice service which was strictly regulated by the Act.

The FCC in March 2002 ruled that cable modem service was an information service not subject to the same regulation as telecom services were under the Act. The FCC suggested then that less regulation would foster the growth of broadband, and by extension, the Internet. In October 2003, the 9th Circuit Court of Appeals overturned the FCC decision, but the Supreme Court eventually overturned the appeal and cable broadband was once again labeled an information service instead of a voice service and hence was not subject to the same regulations as DSL was due to it being offered over a

voice network. This provided sort of a security blanket to the cable broadband industry and allowed it to expand more quickly than the DSL market had in the late 1990s into the early 2000s. The unbundling of local telephone networks did not promote competition the way it was envisioned nor did it increase investment by the telephone companies in expanding and increasing their broadband services.

In February 2003, the FCC voted to phase out rules requiring the large incumbent telecoms to share residential DSL lines at wholesale rates with competing ISPs. After this ruling by the FCC, prices for broadband services began to drop. Competition actually grew due to investors warming up to the idea of building new infrastructure that could compete with the established ILECs. DSL providers started to invest more into their networks knowing that they were off-limits to new competitors. This provided a sense of security for the local telecommunications companies since the motivation to build and improve their broadband networks was not limited by the fact they had to share whatever they built with new companies wishing to enter the broadband market as well.

### 4. Taxes and Subsidies

Federal subsidies in the form of the Universal Service Fund are used to help finance the cost of broadband deployment to rural areas and low-income regions. The cost of deploying facilities and/or the cost of providing services may require the broadband providers to charge a price which is too expensive for the particular community to afford. In these cases, the government often steps in and offers the broadband providers some sort of subsidy to off set their costs in deploying broadband to an area that they may not be inclined to offer it due to the limited potential for profitability in certain areas. State and local governments often offer favorable loans to service providers or reduced taxes to persuade them to offer service as well.

These subsidies are usually funded by the government requiring the large telecommunications companies to contribute to a fund which is used to maintain the arrangement. The telecommunication companies in turn charge their high end service users a higher rate in order to reduce the charges that rural subscribers might be charged for broadband services. Problems funding the subsidy program are becoming greater now that traditional telephone services delivered via wires which provide the bulk of the

resources for the Universal Service Fund are being replaced by cellular, email and VoIP services. There are now many more people who are eligible for the subsidies as rural and low income areas win more support for broadband services, but the amount of people using the traditional high-end telephone services which pay for those subsidies are now beginning to shrink in size.

The wide use of mobile phones and broadband has not gone unnoticed by government. In fact, broadband and, in particular, wireless services are increasingly viewed by state and local governments as a quick and easy way for raising new revenue. The state and local tax burden on communications is now two and a half times what it is for other businesses such as electricity, waste disposal, water, etc. This has created a discriminatory tax burden on the telecommunication industry, as well as a regressive tax increase on every user of telecommunication services which broadband is a large part of in today's market. Today in some states, taxes on cell phones exceed that of liquor and tobacco.

Another problem with the telecommunications tax system today is that, in a world where voice, video and data communications are merging into almost indistinguishable packets of electrons, taxes still discriminate based on the type of telecommunications service being provided, with traditional telephone service being the most heavily taxed. Even though these are an inequitable and excessive telecom tax burden, changing the system is not easy because those taxes supply significant revenue streams to both the state and local governments. Getting the state and local governments to part with this income is difficult and often impossible.

It is often the case that state and local governments still use the tax laws which were based on the monopoly telecommunications era. These taxes are levied at rates significantly above those of consumption taxes (typically sales and use taxes) on other goods and taxable services. Excessive telecommunications taxes were first levied in an era of monopoly service when customer demand was price-inelastic, meaning that customer demand was not at all responsive to price. Under these market conditions, an additional tax could be imposed on the company and passed on to consumers as higher prices without significantly reducing demand for the service.

Today, there is no longer a monopoly in the telecommunications industry. Broadband subscribers are affected by price significantly now and will be more prone to change service providers if a significant increase or drop in price occurs. Economists call this price-elastic. The affect taxes have on telecommunications have on the market have been studied recently. As an example, recent studies have estimated that the price elasticity of demand for wireless services is between -1.12 and -1.29 percent meaning that every one percent increase in price reduces the demand of the service by between 1.12 and 1.29 percent.[61] Even though this study was done on wireless telecommunication, tax burdens on the wired telecommunication have similar outcomes.

Not all the tax news is bad though for the telecommunication and cable companies. Some companies are using old tax laws to minimize their tax burden. Take for instance Verizon Wireless which has a significant amount of business in Boston, MA. In 2005, Verizon Wireless, part owned by the foreign telecommunications company Vodafone based in England, significantly reduced its tax burden. Due to laws established in 1915 to help out fledgling telephone companies in Boston, telecommunications companies were given special tax treatment. Verizon Wireless took advantage of these laws in 2005 by transferring the titles of their telecommunication equipment based in Boston to a Bermuda-based company. This effectively decreased their taxes from three million dollars to around $10,000 practically overnight and it also left Boston three million dollars short of what it had expected to collect in taxes that year.

Many lawmakers want to help alleviate the burden of taxation on telecommunications companies and their customers because they recognize that lower taxes will spur additional demand for services, which will in turn, provide companies with more money to invest in high-speed telecommunications networks. But, the state and local governments have come to depend on the revenue that is generated through these high taxes. Solutions to solving these tax problems are tenuous, but the convergence of new communications technologies, including VOIP, is putting additional pressure on states and local governments to confront the unfairness inherent in current telecommunications tax policies. Just as the Internet generated productivity gains that

[61] MacKey, p. 2.

were widely credited with boosting economic growth in the 1990s, tax policies that promote broadband deployment can have an important economic benefit for state and local economies, especially in rural and underserved areas.

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# IV. COMPARISIONS WITH OTHER COUNTRIES

## A. WORLDWIDE

Worldwide broadband use is on the rise. DSL dominates as the main provider of broadband in the world while cable modem is nearly half as popular. As China begins to update its telecommunications' infrastructure, its immense population will begin to dramatically influence what technology maintains its lead as the number one broadband provider worldwide. Early indications are that DSL will continue to dominate as more countries begin to deploy broadband service over infrastructure already incorporated into the specific regions.

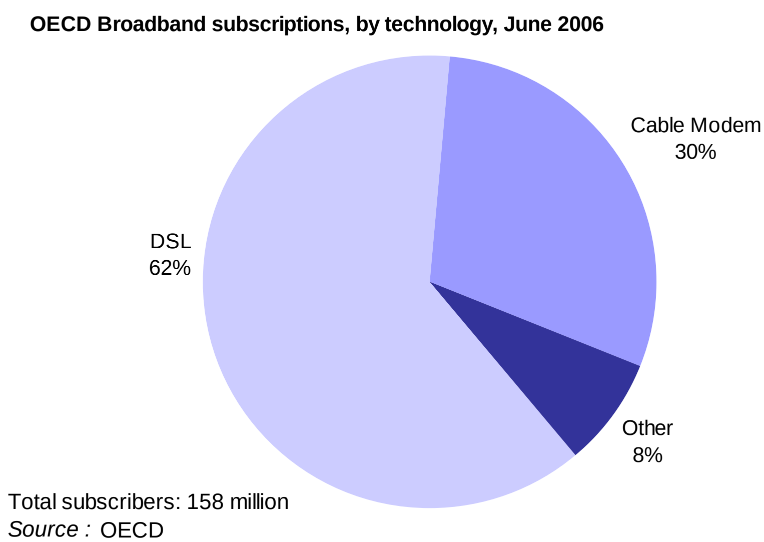


Figure 15. World-wide broadband subscriptions by technology (From OECD).

| Broadband Speed and Data Prices in Selected Countries | | | | | |
|---|---|---|---|---|---|
| Country | Provider | Type | Price $/month | Speed Down mbps | Speed Up mbps |
| Canada | Bell Canada | ADSL | $48.81 | 5 | 0.8 |
| | Cogeco | Cable | $68.29 | 10 | 1 |
| France | France Telecom | ADSL | $72.12 | 8 | 1 |
| | Noos | Cable | $42.73 | 10 | |
| | Free | ADSL | $36.72 | 20 | 1 |
| Japan | NTT West | Fiber | $36.58 | 100 | 100 |
| | J-Com | Cable | $98.20 | 30 | 2 |
| | Yahoo BB | Fiber | $39.22 | 100 | 100 |
| United States | AT&T | ADSL | $39.30 | 3 | 0.384 |
| | Comcast | Cable | $72.20 | 6 | 0.768 |

Table 20. 2006 broadband speed and data prices in selected countries (From www.speedmatters.org).

## B. ASIA

### 1. South Korea

According to the OECD, South Korea is the number one ranked nation in Asia broadband penetration. Prior to 1997 South Korea did not have a very high rate of Internet usage. However, after the government of South Korea had to ask for a loan from the IMF in 1997, it decided to implement and build a robust knowledge-based economy with a vision that broadband service should become a universal service just like the telephone service. With that vision, South Korea invested more than 0.25% of its GDP to build a high-speed backbone and also invested more than 0.25% of GDP in loans to broadband operators from 1999-2001.[62] In July 1998, the first broadband services were launched in South Korea. Over the 10 years between 1997 and 2007, Korea went from no broadband access to approximately 70% of households wired for broadband.

Governmental involvement has been a key to South Korea’s broadband penetration success. South Korea’s commitment to transform its population to a knowledge-driven society has produced a very high literacy rate which in turn has promoted the importance of having broadband access. South Korea has a tradition of constructive and proactive government policy and involvement in building industry and technological capability to be competitive in the international market. The governmental

[62] Kim, Moon, and Yang, p. 4.

polices promote market competition in telecommunications and Internet services industries, support small high-tech businesses, and boost demand for computer and Internet use among its population. These three main policy implementations have created a formidable broadband market in a country that was near the bottom of the world rankings in Internet use prior to 1999.

Incremental deregulation of basic telecommunication services began in 1990 and has helped to promote the building of broadband infrastructure. Few entry barriers for potential Internet service providers also resulted in nearly 55 ISPs by 2000. From 2001 to 2003, South Korea experienced a growth factor of seven in broadband subscribers growing from 5.4 million to 37 million which was made possible through the successful creation-demand policy of the South Korean government.[63] The gluttony of ISPs provided intense competition for new customers. This has resulted in monthly fees of $19 US for 2 Mbps service and $33 US for 8 Mbps. South Korea's price per 100 Kbps was $0.07 at the end of 2005 which ranked it second only to Japan as the cheapest broadband service in the world. Another policy implementation in South Korea was the promotion of high-tech industries by handing out tax incentives as well as low cost loans. Since a lot of the high-tech industries were IT related, they played a large role in the diffusion of broadband services to their customers and created a high demand for faster Internet services.

The next notable policy implementation was the "Ten Million People Internet Education" project. This project educated socially-disadvantaged groups in Internet literacy. Targeting housewives, the government of South Korea educated 10 million people through this program. Increasing the Internet literacy rate enabled a large portion of the households to become aware of the advantages of the Internet and usefulness of greater connection speeds. The government also funded 100 percent of primary and secondary schools with broadband access and promoted the use of the e-government programs to utilize the Internet for public services. The introduction of the Cyber Building Certificate system in 1997 has lead to the widespread diffusion of the popular Internet café named PC-bang. Through PC-bang, South Korean Internet users grew

[63] Sciadas, p. 86.

accustomed to high-speed Internet access which accelerated the diffusion of broadband access to the home.

What makes South Korea stand out is that it is not a wealthy nation according to the World Bank and it has a significant population (more than Hong Kong, Singapore, or Taiwan). Its demographics and its economic standing are not particularly suited for having the highest Internet penetration in Asia. What South Korea lacks in these areas, it has made up with long range planning and effective policy that has guided its broadband penetration. Its largest telecommunication company is Korea Telecom. This former government-owned company was privatized and the South Korean government divested its last remaining share of the company in May 2002. The progressive liberalization of its telecommunication sector during the 1990s which started with the partial and eventually full divestment of government held telecommunications companies has created opportunities for competition among new entrants into the telecommunication sector, and it also had a major impact on the broadband development in South Korea.

South Korea requires its telecommunication operators to contribute to government programs for industry improvement. Unlike the many other countries that require similar contributions, South Korea reinvests this money into the telecommunication sector directly instead of to other areas of government. It is a direct benefit to the entire industry. South Korea's telecommunication market is also very open meaning market entry is contingent upon governmental approval depending on what service is provided.

South Korea's population is 80 percent urban. This makes it easier for broadband penetration because of the dense urban geography which consists of popular high-rise apartment buildings and close proximity to telephone switching stations.[64] Competition for costumers fueled price wars in the broadband markets. By October of 2001, there were seven broadband providers in South Korea. ADSL service was available to 90 percent of the households in South Korea and cable television lines passed 57 percent of the Korean homes.

[64] The average distance to a switching station for a customer in South Korea is about 2.2 Km. 95 percent of the population is within 4 Km of a switching station making it ideal for ADSL service. (Kelly, et. al.)

Local loop unbundling (LLU) was introduced in South Korea in 2002. It has brought intense broadband competition to the incumbent telephone companies. In order to compete, newer and faster technologies was created and installed which has led to nearly 100 percent broadband penetration in Korea. Greater choices and lower prices among broadband providers have created some of the lowest prices for broadband in the world. South Korea's "copy-cat" mentality of its people has promoted the distribution of broadband to the home since once a neighbor or friend had something of importance that made the other person want it even more.

In South Korea, the government heavily subsidized telecommunications companies to encourage them to lay fiber to villages and towns. South Korea's broadband situation is a direct result of its effective policy leadership by its Ministry of Information and Communications (MIC). Korea's pro-active approach in promoting investment in broadband infrastructure has been a leading factor in its overwhelming success in broadband penetration.

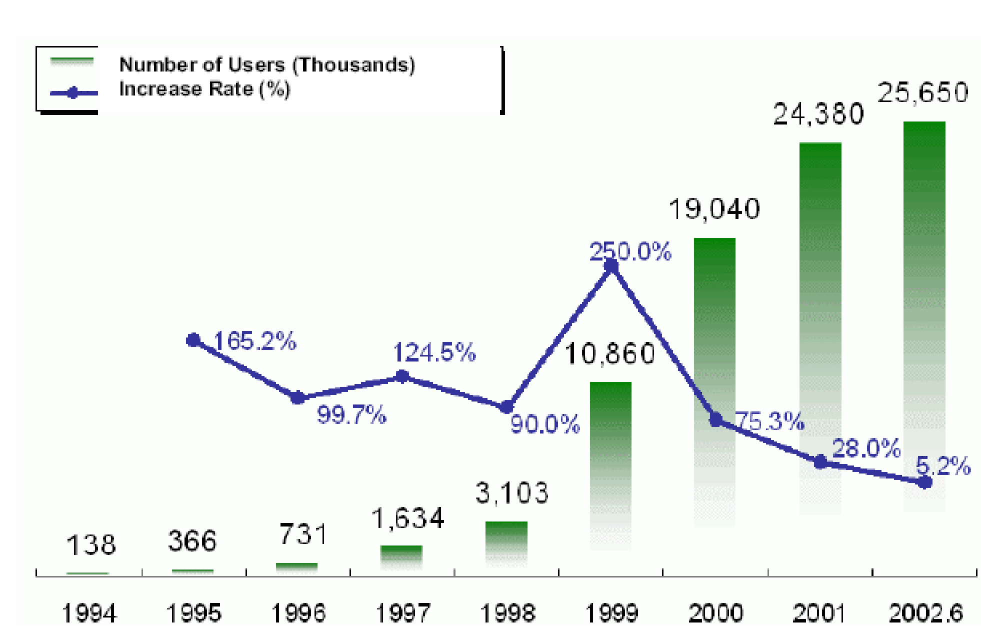


Figure 16. Number of Internet users in South Korea (Korean Network Information Center).

### 2. Japan

In 2001, Japan was well behind the United States in the broadband race. But thanks to top-level political leadership and ambitious goals, it soon began to move ahead. By May 2003, a higher percentage of homes in Japan than in the United States had broadband, and Japan had moved well beyond the basic connections still in use in the United States. Today, most Japanese consumers can get an Internet connection that's 16 times faster than the typical American DSL line for a mere $22 per month.[65] Symmetrical 100Mbps connections are available for less than $35 per month. Those speeds are unheard of for consumer broadband in the US, and prices for much slower hookups are significantly higher.

Japan leads the OECD in fiber-to-the-premises (FTTP) with 6.3 million fiber subscribers in June 2006. Fiber subscribers alone in Japan outnumber total broadband subscribers in 22 of the 30 OECD countries**.** 80 percent of the growth in FTTH subscribers last year was not in the United States but in Japan.[66] Japan's incumbent telephone company, NTT, has provided FTTH to more than 80 percent of the local exchanges, and FTTH is available in all municipal cities. Aggressive planning and governmental incentives have helped Japan become one of the fastest growing nations in terms of broadband speed and capacity.

Thanks to the government's competitive framework, the speed of the DSL service offered rose dramatically, from eight megabits per second in 2001 to 12, 26, and 40 megabits as of 2005. As capacity increased, the prices for the broadband service remained stable at about $22 per month, the lowest in the world. Even with the dramatic increase in speed over DSL offered to its customers, Japan needed "ultra-fast" 100 Mbps connections in order to provide video and rich telecommunications applications to its customers.

In order to meet that goal, Japan began laying a fiber network that was capable of 100 Mbps service. It was decided that those lines, too, should be open to competition, so the Japanese authorities devised significant tax incentives, debt guaranties and partial

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[65] Turner, p. 1.

[66] Copps, p. A27.

subsidies to persuade Japanese companies to invest in new ultra-high-speed fiber, especially in rural areas. These measures were sufficient enough for new fiber in the cities and large towns, but the municipalities in the smaller towns and rural areas required even more significant incentives by the Japanese government to build their own fiber networks and then leave them open for competition. The Japanese government decided to cover up to one third of the cost it took to build the new fiber networks in the rural areas provided that the municipalities kept the networks open to outside access.

By the end of 2002, ultra-fast fiber connections were available to more than 10 million households in Tokyo and Osaka. Competition on the new fiber networks increased dramatically with the government's mandate of open access and soon prices for 100 Mbps service over the fiber networks fell to $35-45 per month. Although FTTH connections were economical in densely populated areas, providing the fiber connection all the way to the home in less dense areas was cost prohibitive for the private companies as well as for the government. In those cases, the government still provided subsidies to the telecommunications companies to at least provide a fiber node in every neighborhood. The government left it up to each household to decide how to connect to that fiber node. Some have decided to pay for a direct fiber connections themselves while others connect via the cheaper and slower wireless methods. This government initiative provided nearly 80 percent of Japan's residents' access to ultra-fast broadband connections by 2004.[67]

## C. EUROPE

### 1. Scandinavian Countries

Denmark now leads the OECD with a broadband penetration rate of 29.3 subscribers per 100 inhabitants. In Denmark, 79 percent of the population has Internet access at home while 97 percent of the population is covered by broadband enabled networks.[68] Dial-up and ISDN still make up 50 percent of those Internet connections, however, and those services still charge by the minute. At the end of 2005, Denmark's

[67] Bleha, p. 2.

[68] Stafford, p. 1.

broadband infrastructure was accessible to nearly 98 percent of its population.[69] Cable Internet speeds reach 4 Mbps download/1 Mbps upload, albeit at a rather expensive price of $101. DSL, with speeds of 4 Mbps download/256 kbps upload, costs a little less, at $73. Fiber-optic service is being rapidly deployed, especially in larger cities, and Broadband over Power Line (BPL) is available in some regions as well. Even with its flat geography and dense population, Denmark's broadband subscribers seem to be looking past wireless options for broadband access and instead turning to faster alternatives all together. Denmark's government forced the telecommunications companies to unbundle their local loops in 1998 which has provided enough competition where there are low prices, but still enough investment in new technology and further infrastructure building.

The strongest per-capita subscriber growth comes from Denmark, Australia, Norway, the Netherlands, Finland, Luxembourg, Sweden and the United Kingdom. Each country added more than 6 subscribers per 100 inhabitants during 2005-2006. Norwegians have the option of connecting to the Internet via DSL at 20 Mbps for about $75 per month. Cable broadband access is available up to 26 Mbps, but the price is expensive at $144 per month. For those that do not want to pay so much money for the access, there is also a cheaper and slower cable broadband access option which offers 1.5 Mbps download and 350 Kbps upload connection at $43 per month. In Finland typical broadband connections are 512/512 Kbps and 1 Mbps/512 Kbps for €20-30.

Scandinavia has a progressive municipal approach to fiber deployments for the benefit of its citizens and regional economic welfare, leading to one of the widespread fiber footprints in Europe. Overall broadband access in Scandinavia is high. Global coverage of broadband in these countries ranges from 70 to 90 percent.[70] This is the highest penetration in all of Europe. New fiber networks being laid will increase the access speeds which may enable Scandinavia to compete with Japan and South Korea for broadband speed. Innovative policies as well as excellent governmental leadership and vision have enabled the Scandinavian countries to be ranked as some of the top broadband countries in the world.

[69] Denmark's National IT and Telecom Agency.

[70] Fransman, p. 183.

### 2. Germany

Germany is Europe's largest economic and second most populous country. It is overwhelmingly dominated by one private company named Deutsche Telekom (DT). In 2002, DT had controlled nearly 94 percent of Germany's broadband market and by 2004, this percentage dropped slightly to 88 percent.[71] Germany's lack of inter-modal competition between its cable and DSL broadband providers is one reason why DT has such a large share of the broadband market. Another is the lack of DSL competitors to compete with DT's own DSL. RegTP is Germany's telecommunications regulator. Its failure to open up DT's lines to competition for so long has created Germany's broadband problem.

In 2006, Germany enacted stricter mandates on DT by requiring DT to lease its high-speed data lines to rivals on more generous terms. This is similar to what the United States attempted to do when the 1996 Telecommunications Act required incumbent telecommunications companies to lease some of their network capacity to rivals at wholesale prices. The United States' regulation plan backfired and later was rescinded in March 2004 by federal judges. The results of the German plan can not be fully measured yet because it is too early, but Germany's hope is that these new mandates will be a quick and dirty way of creating new retail rivals and hence more competition among broadband providers.

As of June 2006, broadband penetration in Germany was 14.7 per 100 persons, putting it toward the bottom of Western European countries. The performance laggard is not DSL, which the European Union regulators are now attacking with more stringent regulations, but cable-modem service. The leading broadband markets in Germany already feature competition between cable and telephone broadband services, yet Germany has just 0.3 cable modem subscribers per 100 inhabitants despite having been wired nationwide for cable television years ago. This is the lowest total for any country with nationwide cable infrastructure.

Germany's hope of rising in the rankings of broadband countries is highly dependent upon its deregulation of the cable television industry. Germany's

[71] Fransman, p. 167.

overregulation of its cable broadband industry has caused the broadband distribution problem it is facing. In Germany, the cable companies are by law divided into four discrete layers. The owners of wires are not permitted to market services, own program networks or create content. This makes for a very inefficient business model, and it limits the vertical integration within the cable industry. This inefficiency has caused the cable companies to not invest in the digital upgrades necessary for broadband data services to be carried over their networks.

With the new sharing regulation push by the European Union for DSL services and fiber-to-the-premises, Deutsche Telkom is resisting any further regulation changes that might prevent them from investing heavily in newer broadband technology and expansion of their broadband network. At the end of 2006, DT requested what is known as a “regulatory holiday” on its high-speed vDSL technology which it has heavily invested in. DT is demanding a regulatory moratorium, which would effectively prevent competitors from gaining access to its newly upgraded broadband network. The European Competitive Telecommunications Association (ECTA) has warned that Germany’s broadband growth could be in serious jeopardy if this demand is met. From 2002 to 2006 the ECTA has been battling to open up Germany’s DSL-broadband services and with DT’s request the ECTA is particularly disturbed due to the potential long-term effects on consumers not only in Germany, but Europe-wide as incumbents copy the tactics to maintain their grip on the telecommunications market.

The fear is that Germany will once again have a monopolized broadband service like it had in 1998 before the government stepped in to dismantle the telecommunications monopoly. With monopolies come high prices, less choice, and ultimately fewer customers. With signs that Germany’s broadband market is making progress with increased competition at the local-loop level as well growth in the overall broadband penetration. DT’s request may nullify these gains and prevent Germany from making further progress. Regulators in Germany have a very important decision to make and many other nations are waiting to see the outcome. In other European nations such as Denmark and the United Kingdom, regulation is generally more effective, and competition is the key driver of investment and adoption of broadband technology. In the absence of competitive challenge, service delivery suffers and markets stagnate.

Germany is a country that appears to be further behind the broadband penetration problem compared with the United States

### 3. France

France's largest incumbent broadband provider is France Telecom (FT) with 57 percent of the market. This puts France in the mid-region of European nations when incumbent's share of the market are consider. Compared with the U.K., Sweden, or Belgium where the incumbent's market share is from 30 to 50 percent, penetration of new entrants into the broadband market is lower in France. On the other hand, France is performing better in broadband penetration than Germany and Italy where the incumbent's market share is above 60 percent. FT has played a large role in France's growing broadband penetration. The OECD ranks France number 16 for broadband penetration. Global broadband penetration in France is around 25 percent. Although not ranked near the top in the world, France is performing better than Germany and is progressing up the OECD rankings.

The French regulator, ARCEP, defines its broadband as anything over 128 Kbps which is two times slower than the FCC's broadband definition. As of June 30, 2006, ARCEP said that France had 11.1 million broadband connections. This number has grown very quickly over the past few years. In 2002 there were only 1.6 million broadband subscribers and in 2003 there were 3.5 million broadband subscribers in France. The sudden increase in subscribers is partly due to the significant fall in prices for broadband during that same period in France as well as the new "triple-play" offerings the ISPs started provided which included TV, voice and Internet over the same ADSL line.

DSL dominates the broadband market in France at 94 percent with alternative technologies supplying the other six percent.[72] DSL appears to dominate France's broadband market due to three main reasons: it was the technology the incumbents started with, many of the incumbent's competitors copied the incumbent's DSL strategy in the early stages of disruptive competition and the main broadband equipment maker,

[72]www.arcep.fr.

Alcatel, primarily made DSL equipment. In France, DSL service is 10 times faster than the typical United States connection; 100 TV channels and unlimited telephone service cost only $38 per month.[73]

Cable broadband subscribers number around 393,800 in France. Cable broadband started off strong when broadband was rolled out in France in the late 1990s, but its growth has stagnated today. The cable industry in France still carries unpaid debt from the cable plan that was initiated in 1982 which is a reason the industry should invest heavily in new services and upgrading its old infrastructure. ARCEP also has limited the maximum number of customers to be served on one network to eight million subscribers which has limited the economies of scale the cable companies can provide. Another hidden reason for cable's lack of success is FT's ownership of 40 percent of France's cable networks which means there is a low incentive to develop cable broadband technology.

Other alternative broadband technologies are lagging in France. Prior to 2003, the 2.4 GHz band was still exclusively being used for military/defense purposes. That meant the 802.11b/g protocols could not be used there. FTTH and power-line broadband carrier systems only play a marginal role in France's broadband market. Overall, it seems France's lack of inter-modal competition between cable and DSL broadband technologies is limiting the growth of broadband penetration. The early introduction of competition, both at the technology level and the between companies has stimulated the growth of broadband in France. However, the uncoordinated and strict process of competition that was introduced generated the dominance of the incumbent technology (ADSL), and the underdevelopment of alternative technologies.

## D. THE AMERICAS

### 1. Canada

By early 2000 Canada's broadband sector was among the most advanced in the world. Canada has declared the minimum standard for broadband to be 1.5 Mbps in both

[73] Turner, p. 1.

directions. This is more than seven times faster than what the FCC considers to be "advanced service" in the United States. The number of broadband subscribers number around 6,700,000 broadband subscribers as of November 2005.[74] This ranks Canada as number one in the Group of Seven industrialized countries. Open access to cable and telephone infrastructure has given Canadian residents far greater access to broadband Internet compared with United States' residents. One of the reasons that facilitated greater broadband access is Canada long ago mandated that the local cable and telephone monopolies provide competing ISPs access to their networks at wholesale cost. Industry Canada, the creator and enforcer of Canada's telecommunication policy, has provided active government encouragement of the broadband market in Canada. This has allowed more competition and increased innovation among the ISPs and resident cable and telephone companies wishing to offer its customers DSL and cable modem broadband service.

| YEAR | Users | Population | % Pen. | Usage Source |
|---|---|---|---|---|
| 2000 | 12,700,000 | 31,496,800 | 40.3 % | ITU |
| 2003 | 20,450,000 | 32,050,369 | 63.8 % | C.I.Almanac |
| 2006 | 21,900,000 | 32,440,970 | 67.5 % | C.I.Almanac |

Table 21. Canada's Internet Usage and Population Growth (From www.internetworldstats.com/am/ca.htm).

From 2000 to 2003, Canadian broadband growth has been higher than the United States, but starting in 2004, the United States started to close the gap. Canada still has a higher penetration of broadband compared to the United States, but the United States is showing greater growth rate. Canada may be reaching a point of saturation in its broadband market where the growth rate of broadband will not increase at the same rate it has consistently in the past. The same situation that happened in South Korea where broadband penetration growth rate slowed way down after the market had reached 70 percent penetration. Although the availability of broadband is high, getting people to actually make use of the broadband is something entirely different from providing it. In many countries around the world, once broadband penetration moves to around 70 percent, the growth rates slow down. By 2006 Canada's performance in areas such as

[74] C.I. Almanac.

broadband penetration and mobile penetration started to lag behind its OECD counterparts. This has led to calls for further reform of Canada's telecommunications regulatory regime to a lighter-handed framework. Hence 2007 and 2008 are likely to be characterized by further regulatory reform towards a more market-based approach.

In 2000, only 12.1 percent of all Canadian households had a broadband connection. At the end of 2006, Canada ranked number nine in the OECD for broadband penetration with 77 percent of Canadians households with Internet access used broadband connections (7.1 million subscribers). In the middle of 2006, 95 percent of the communities in Canada are served by at least one broadband provider.[75]

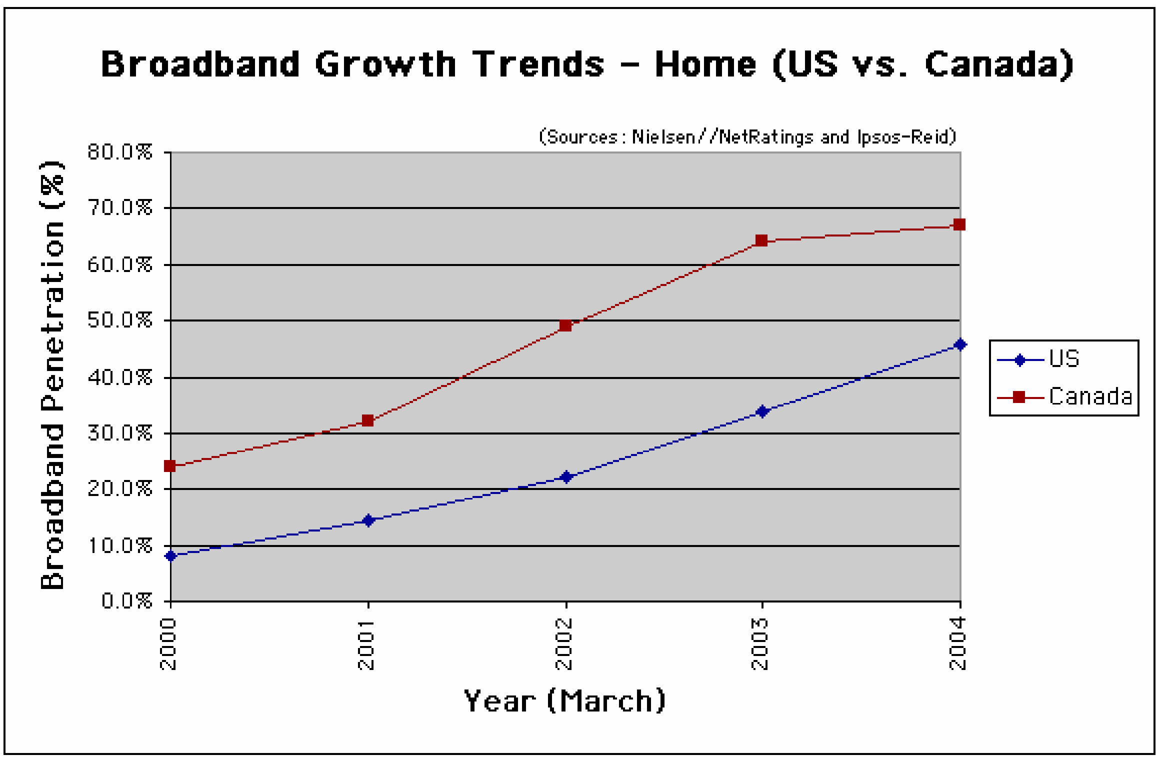


Figure 17. US and Canada broadband growth trends – Home (From Nielsen//NetRatings and Ipsos-Reid).

Cable modem subscribers outnumber DSL subscribers in Canada. In the OECD rankings, Canada has the highest cable broadband penetration out of all other OECD countries at 11.5 subscribers per 100 inhabitants. While penetration is higher in Canada

[75] Statistics found on www.budde.com.au/Reports/Contents/Canada-Broadband-Market-Overview-Statistics-2900.html accessed March 3, 2007.

than in the United States, the price of broadband remains much higher in Canada than it is in the United States. Canada's price per 100 Kbps is $1.01 compared to $0.49 in the United States. FTTH remains in its infancy, but it is becoming more popular as a solution to increasing broadband penetration in Canada. The larger telecommunication companies are focusing more on FTTN rather than the more expensive FTTH strategy at least until 2010. On the regulatory front, the March 2006 Final Report of the Canadian Telecommunications Policy Review Panel calls for a relaxing of the regulations contained within Canada's 1993 Telecommunications Act and for several institutional changes. The Final Report recommends that the new framework should rely on market forces instead of regulatory interference as the means to achieve policy objectives.

### 2. Central America and South America

In Latin America, the biggest hurdle to broadband penetration appears to be economic in nature. Latin America has traditionally been a poorer region of the world. Central America's average GDP per capita is $6,838 compared with world average which is $10,000. For comparison, the United States' GDP per capita is $43,500 which ranks it eighth in the world. The highest ranked Latin American country in terms of GDP per capita is Argentina. Argentina has a $15,000 GDP per capita ranking it number 67 among the nations of the world. Chile is next ranked number 79 for having a GDP per capita of $12,600. Costa Rica is the highest Central American country ranked number 82 in the world for GDP per capita at $12,000.[76]

Economic downturn in Latin America between 2001 and 2003 led to a lack of further investment in the telecommunications sector in the region. Demographics of Latin and Central America lend itself to great opportunities for broadband penetration and use. High population concentrations, with over 70% of the population living in urban areas (close to European levels), enable a good opportunity for both DSL and cable modem. There are also large areas which are considered rural with extreme terrain which may be served best with wireless technologies such as WiMAX or satellite connections.

[76] GDP facts found in the 2007 CIA World Factbook.

The availability and adoption of broadband in Latin American is still well behind North America, Western Europe and much of the Asia-Pacific region. The low number of fixed telecommunications lines and fixed infrastructure in Latin America is also an impediment to expanding broadband penetration. In many Latin American areas, telecom networks simply do not reach users beyond major cities. Until the infrastructure is expanded, only wireless service providers will be able to tap markets beyond urban centers. This may be the bottleneck for broadband in that region unless some type of wireless broadband solution such as WiMAX is adopted.

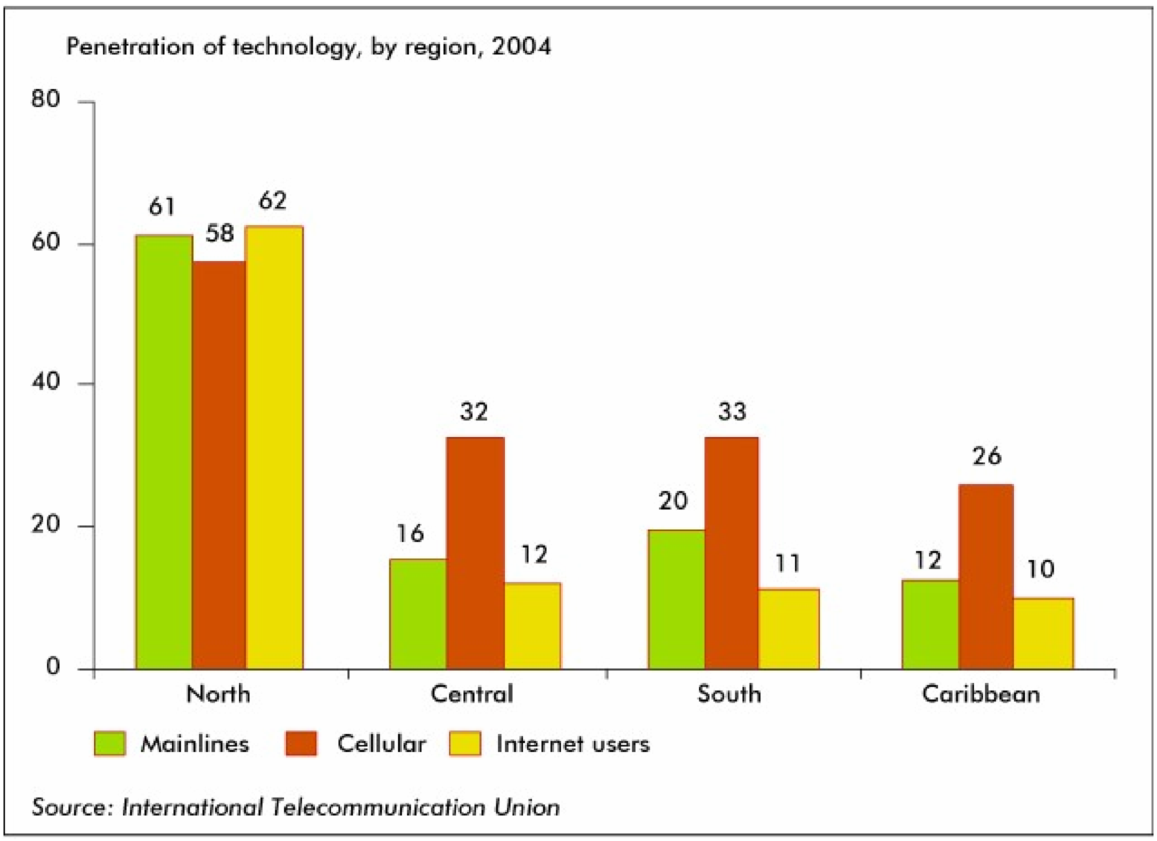


Figure 18. Penetration of telecommunications technology in the Americas 2004 (From ITU).

There are some highlights, though. The Latin and Central American broadband leaders are Brazil, Mexico, Argentina, and Chile, and in early 2006, these four countries accounted for about 90% of all broadband subscribers in the region. In 2005, Latin America was only second to Asia in rolling out WiMAX networks. By April 2006,

WiMAX systems were operating in Argentina, Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Peru, Uruguay, and Venezuela. Typical broadband speeds are increasing from 256 Kbps to 512 Kbps throughout the region. The most popular broadband technology is ADSL which grew by 88 percent in 2005. Many nations in Central America appear to be liberalizing their telecommunications markets making them more open to competition and less regulation. This is good news for Central America's broadband penetration problem. A lot of the Latin nations now realize the economic stability broadband penetration creates and are acting accordingly to increase the penetration rates to their residents. A few countries like Venezuela have re-nationalized their private telecommunications industry which could lead to less innovation and competition among the telecoms there to expand their broadband technology.

| Central America | Population 2007 (est) | Internet Users, Latest Data | % Population (Penetration) | % Use C.A. | Use Growth (2000-2007) | GDP (purchasing price parity) | GDP per Capita |
|---|---|---|---|---|---|---|---|
| **Belize** | 312,233 | 35,000 | 11.2 | 0.2 | 133.3 % | $2.31 billion | $8,400 |
| **Costa Rica** | 4,504,013 | 1,000,000 | 22.2 | 4.3 | 300.0 % | $48.77 billion | $12,000 |
| **El Salvador** | 6,672,218 | 637,100 | 9.5 | 2.7 | 1,492.8 % | $33.2 billion | $4,900 |
| **Guatemala** | 13,110,745 | 756,000 | 5.8 | 3.2 | 1,063.1 % | $60.57 billion | $4,900 |
| **Honduras** | 6,827,496 | 223,000 | 3.3 | 1.0 | 457.5 % | $22.13 billion | $3,000 |
| **Mexico** | 106,457,446 | 20,200,000 | 19.0 | 86.7 | 644.7 % | $1.13 trillion | $10,600 |
| **Nicaragua** | 5,701,141 | 140,000 | 2.5 | 0.6 | 180.0 % | $16.83 billion | $3,000 |
| **Panama** | 3,172,537 | 300,000 | 9.5 | 1.3 | 566.7 % | $25.29 billion | $7,900 |
| **Total** | 146,757,829 | 23,291,100 | 15.9 | 100.0 | 623.9 % | $1.34 trillion | $6,838 |

Table 22. Central America Internet Usage and Population (From www.internetworldstats.com[77] and CIA World Factbook)

One of the top Latin nations in broadband penetration and success is Argentina which has a strong wire line and cable TV foundation offering enormous potential for DSL and cable modem broadband access solutions. As of March 2006, Broadband connections in Argentina reached 1,043,289, with a 2.7 % penetration of the country's total population. Prices range from $35-48 per month for 2.5-5Mbps download and

[77] (1) Internet Usage and Population Statistics for Central America and Mexico were updated on Jan. 11, 2007. (2) Population numbers are based on data contained in world gazetteer. (3) The most recent usage comes mainly from data published by Nielsen//NetRatings, ITU, and other trustworthy sources.

256Kbps upload speeds.[78] The Argentina government has proposed a goal of at least four million broadband connections for the year 2010. There is still a long way to go, if one compares it with the indices for other countries, such as Canada (18 %) and South Korea (26 %). 67 percent of Argentina' population is concentrated along a corridor from Buenos Aires to Santa Fe which is served by fiber optics. This corridor consists of 91.6 percent of all the broadband connections in the country. [79]

Brazil has also announced its goal of having more than 10 million broadband connections by 2010. Brazil is the fifth largest country in terms of geography and population in the world ranking just behind China with 8,511,965 square kilometers and Indonesia with 184,101,109 people.[80] At the end of 2005, Brazil had 3.6 million broadband connections which comprised of 1.9 percent of its population. The cost per 100 Kbps is $1.08 in Brazil which is over double the price of the United States' price per 100 Kbps which is $0.49. As of late 2004, a common ADSL broadband plan with download speeds between 300 Kbps and 1 Mbps costs $42-56 per month.[81] Brazil's broadband penetration is one of the lowest rates in not only Latin America but also worldwide. The good sign is the government of Brazil sees the advantages that broadband penetration gives its population as well as how it will increases the standard of living. The government of Brazil is now looking ahead and planning accordingly to increase its broadband penetration.

Mexico's telecommunications regulatory body is called the Federal Telecommunications Commission (COFETEL) which was created in 1996. Mexico has been focusing on liberalizing its telecommunications market ever since its president, Salinas de Gortari, announced in 1990 the privatization of Mexico's largest incumbent telecommunications company Telmex as part of its ambitious economic liberalization plan. Thus, an enormous, undivested government monopoly was privatized and became a private monopoly with a gradual introduction of competition. Unfortunately, Telmex still owns 94 percent of Mexico's fixed line infrastructure preventing any real

[78] Wikipedia.org-Broadband Internet Access Worldwide, accessed March 5, 2007.

[79] "Cisco Launches Broadband Barometer in Argentina."

[80] CIA World Factbook.

[81] Wikipedia.org-Broadband Internet Access Worldwide, accessed March 5, 2007.

competition from new telecommunications companies wishing to enter the market. Telmex has concessions from the Mexican government to provide voice, data, text, and multimedia services until 2026.

The local loop was opened to competition in 1998. Because of the near monopoly that Telmex holds, Mexico's price per 100 Kbps is $6.25. This excessive price is a large barrier for Mexicans that wish to adopt broadband access. For a typical 1 Mbps download and 128 Kbps upload broadband plan it costs about $37 per month.[82] Mexico is less developed than some of its regional peers such as Argentina or Chile. Fixed wire line infrastructure is not as prevalent in Mexico which might mean fixed wireless technologies like WiMAX could provide extensive opportunities in expanding broadband penetration and use throughout the country. Mexico's largest cellular company is Telcel, a wholly-owned subsidiary of Telmex. Telcel controls about 77 percent of the mobile phone market in Mexico. A few new cellular companies, Lesacell and Unefon, are offering 3G technology which may produce more competition and further penetration of broadband through wireless means.

The broadband market in Mexico is still lacking. 51 percent of Mexicans are poor and 25 percent live in extreme poverty.[83] The World Bank and the Inter American Development Bank have strongly recommended to Mexico that it adapt a visionary, strategic, and comprehensive broadband Internet policy that cuts across all the federal agencies of Mexico and is tightly linked to an even broader policy of sustainable development.[84]

## E. RANKING THE UNITED STATES

According to the 2006-2007 Global Competitiveness Report by the World Economic Forum, the United States ranks as the sixth most competitive economy in the world behind Switzerland, Finland, Sweden, Denmark, and Singapore. It showed the most pronounced drop since 2005 dropping from number one to number six in the world. Many policy makers and politicians are concerned that the United States does indeed lag

[82] Wikipedia.org-Broadband Internet Access Worldwide, accessed March 5, 2007.

[83] Hanson, p. 4.

[84] Hanson, p. 2.

in broadband penetration and use. This worries the politicians because it might mean the United States may not continue to be competitive on the world economic front resulting in not being able to share the benefits of economic growth with all of its residents. While more households are adopting broadband, the United States' relative position in the world is worsening. The country has fallen to 16th among the major industrialized nations in terms of broadband adoption even though the United States is the home of the computer and the Internet.

Not only is broadband less widely available in the United States than in other countries, it is also slower. The cause of this is not a simple cut and dry answer, but it can be attributed to a few factors when comparing the United States' broadband penetration problem with the success and failure of the other countries around the world. One fact can be certain. A stronger line was taken with incumbent telephone companies in other countries such as South Korea and Japan than was in the United States. Korea and Japan's regulatory oversight has indeed been stronger than what has been done in the United States. Insufficient investment in new broadband infrastructure due to the unbundling policy set forth by the 1996 Telecommunications Act has delayed the United States' broadband penetration.

A lot of the countries that have faster broadband access with more broadband penetration than the United States have something the United States lacks: a national broadband policy, one that aggressively encourages competition among providers, leading to lower consumer prices and better service. Instead, the United States has fragmented governmental programs and a handful of unelected and unaccountable corporate giants that control our vital telecommunications infrastructure. The United States has tended to swing between over-regulation and a hands-off, purely market-driven approach, neither of which, it could be argued, has served it well over the long term. This has led not only to a digital divide between the United States and the rest of the advanced world but to one inside the United States itself. Broadband services in the United States remain unavailable for many living in rural and poorer urban areas, and remain slow and expensive for those who do have access.

The United States' broadband prices fall towards the middle to bottom of the world rankings. Northern European countries along with Eastern Asian countries such as South Korea and Japan rank near the top in price for every broadband technology.

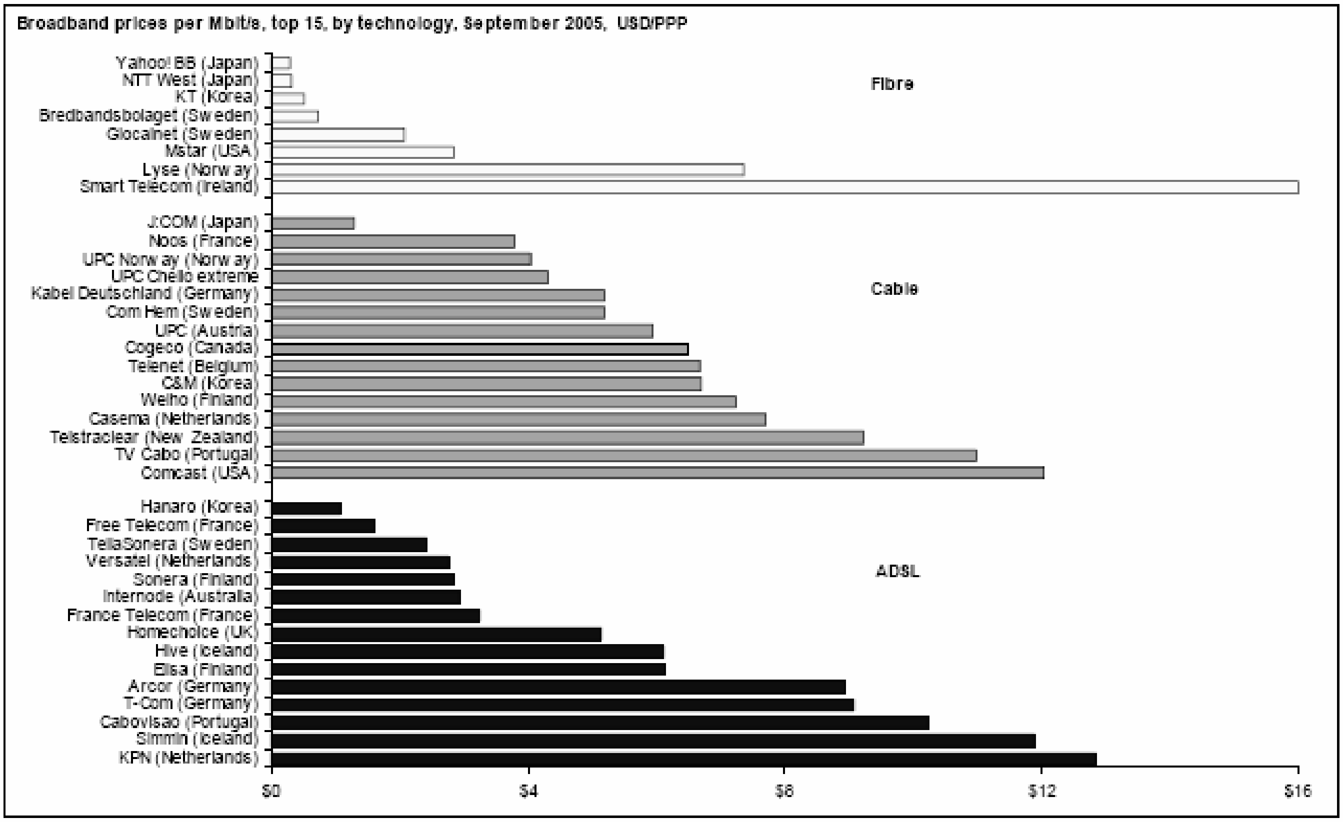


Figure 19. Broadband prices per Mbps, top 15 firms, by technology, September 2005, USD/PPP (From OECD).

In 2003, the lobbying power of the incumbent telecommunications companies in the United States (SBC-now AT&T, Verizon, Bell South-now At&T), successfully managed to change the unbundling rules on incumbent telephone companies. This has had a two fold affect. The first affect expected was the increase in incentives for new broadband infrastructure investment by the ILECs. Since the ILECs were no longer expected to lease their network to CLECs (Competitive Local Exchange Carrier), they would be more inclined to investing in new broadband infrastructure, furthering the broadband penetration in the United States. The second effect of the unbundling rule changes was negative. After the ILECs no longer had to provide wholesale access to CLECs, there was no more competition on the local loop from competitors.

Less pressure from competitors may also provide fewer incentives to the ILECs to move towards superior broadband technology like FTTH. Prior to the regulation changes by the FCC regarding unbundling practices, the ILECs had promised to develop FTTH infrastructure is relieved of the unbundling and line sharing rules. These promises were not kept by the ILECs (SBC-now AT&T and Verizon) once the rules were changed. Instead, AT&T is now proceeding with the cheaper method of FTTC instead of the FTTH. Verizon, however, is beginning to invest in FTTH in select regions of the country. Empty promises have hurt the customer, but have lined the pockets of the corporation with profits realized from the cheaper and less capability of FTTC.

Inter-modal competition between the cable companies and the DSL providers is what is working in the United States. This competition has been good and will bring important benefits over time, including the rapid deployment of "triple-play" features that include voice, Internet, and TV/video services bundled by one provider, but this oligopolistic competition where neither side has an interest in dramatically changing the current market through disruptive activities has similar affects as a monopolistic market.

This is in contrast to the model used in Asia and Europe where intermodal competition is provided by the DSL incumbents and their competitors who are able to access their local loops at wholesale prices. Competitors and incumbents in this situation are willing to implement disruptive measures in order to gain a greater share of the broadband market. Satellite and cellular broadband networks cannot yet offer the same quality of services that DSL and the cable broadband providers can provide due to pricing and speed limitations. This is why those companies are not able to provide the disruptive measure necessary to promote competition to the DSL and cable broadband companies.

The oligopolistic competition between the cable companies and the DSL providers was played out initially when DSL providers began to market their services more aggressively in the same area where cable TV was once the only broadband provider. Cable companies responded by increasing the download speeds of their network but not lowering prices of their broadband service. This seems to be the consequence of inter-modal rivalries which seems to value service competition over price competition which may lead to the lower intensity of competition in the broadband

market in the United States compared with other countries. The intensity of competition also looks as if it is less in the United States than it is in Japan or Korea which leads to a conclusion that the United States will not be able to eliminate the gap in broadband penetration any time soon. The reasons are simple: cheap, high-speed broadband would lead to widespread use of Internet telephones and thus threaten the phone companies' lucrative voice-telephone business, and more inexpensive broadband would multiply outside video and movie offerings and endanger the cable companies' profitability.

Throughout its history, the United States has benefited from major technological advances such as railroads in the 19th century and telephones and national highway systems in the 20th century because it had some national policy which governed wide spread use. It is now the 21st century and the new technological advance is broadband Internet access, but the United States does not have a uniform broadband policy that is ensuring the widest penetration and equitable deployment. The lack of strong incentives to encourage competition has destined broadband in the United States to remain much slower and more expensive than in countries like Japan or South Korea.

The FCC chairman, Kevin Martin, wrote an editorial in the April 3, 2006 edition of the London-based Financial Times saying that the OECD rankings do "not tell the full story." Martin argued that the low population density of the United States made comparisons with high-density countries like South Korea or Denmark unfair. However, the experience of countries like Iceland, Norway and Sweden, which have even lower population densities than the United States, does indicate that low density is not an insurmountable obstacle to wider broadband access.

In many of the countries at the top of the OECD rankings, the governments have taken an active role in spurring broadband use and in some cases in building communications infrastructure as they would a public utility like highways or airports. Aside from the obvious geographical and demographic advantages accruing to small nations with large urban populations, broadband development thrives when it becomes a national priority. Both developed and developing nations have stimulated capital expenditures for infrastructure in ways United States public and private sector stakeholders have yet to embrace.

In the most recent data available from the National Science Foundation, the amount of federally funded R&D as a percentage of industrial provided funds has been falling continuously since 1990 (See Figure 19 and Table 22). Although the telecom and cable TV industry have invested more of their own money in R&D over that same period, the federal government's share has fallen. The R&D tax incentive program, established temporarily under the Economic Recovery Tax Act of 1981, was most recently renewed under the current Bush administration.[85] Its temporary status as well as limited funding has harmed its effectiveness.

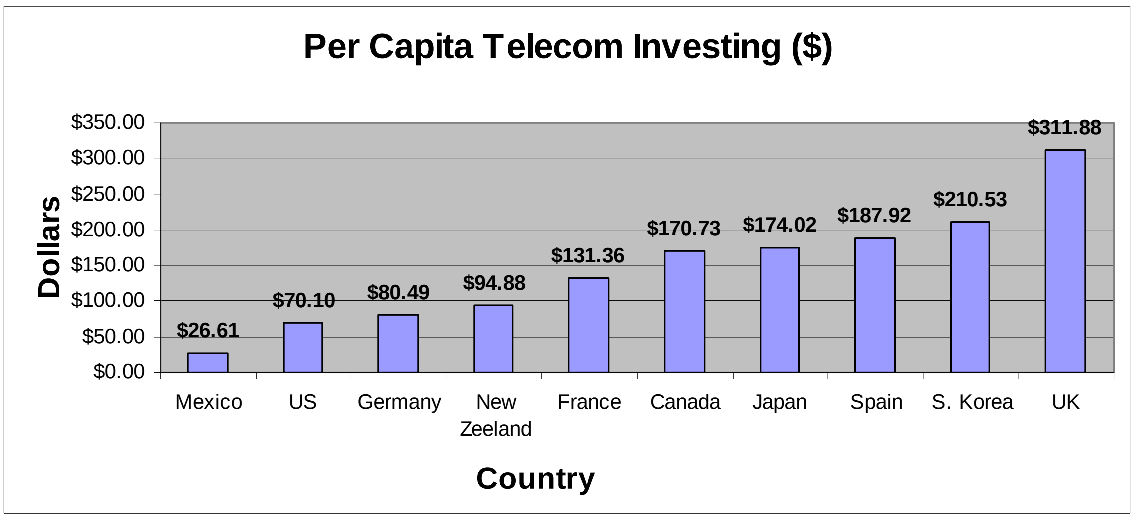


Table 23. Telecommunications investment per capita.[86]

[85] Morris, p. 1.

[86] This is an estimated value using 2006 population and GDP estimates. Telecom investing information is found at www.speedmatter.org accessed March 7, 2007.

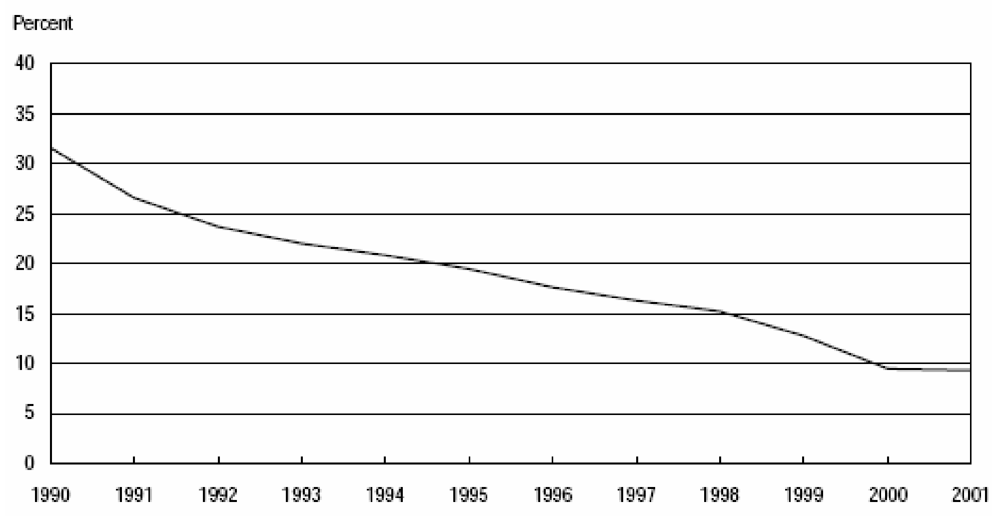


Figure 20. Federal funds for industry R&D as percentage of industry-funded R&D expenditures from 1990-2001 (From Morris, p. 4).

In 2001, Robert Crandall, an economist at the Brookings Institution, and Charles Jackson, a telecommunications consultant, estimated that "widespread" adoption of basic broadband in the United States could add $500 billion to the U.S. economy and produce 1.2 million new jobs. Washington never promoted such a policy. In 2004, another Brookings economist, Charles Ferguson, argued that perhaps as much as $1 trillion might be lost over the next decade due to present constraints on broadband development. Globalization has enabled countries to find cheaper goods and services through the use of the Internet. Being able to provide those services and increase productivity is dependent upon an adequate broadband network where every household and business can connect to the Internet at high-speed rates. The United States may continue to lose jobs and revenue to other countries because of its lag in broadband access.

An interesting comparison can be done using the population or the population density of a country to its broadband penetration. Some people will conclude the reason the United States has such low broadband penetration is because of its large population and geography. The United States is the third most populous country in the world as well as the third largest in geography. Combining a large population over a large area does indeed require more effort in order to connect everyone to broadband. Therefore, the United States is naturally going to have a difficult time keeping up with the top nations in

the world as far as broadband penetration rates go. Most of the leading nations in the OECD broadband penetration report (Appendix A.) have considerably less population than the United States and their geography is also notably smaller than the United States.

There have been studies that show that population density does not have as large of an effect on broadband penetration as GDP per capita does, however. Appendix E shows two tables which show broadband penetration of the top 30 countries according to the OECD along with the GDP per capita and population density of the countries plotted on top of the penetration data. Interestingly, there seems to be a better mapping of GDP per capita data to the broadband penetration data. The greater the GDP per capita of a particular country, the more likely it has a higher broadband penetration rate in the OECD. The countries which have greater wealth often have better broadband penetration. Population density has little to do with whether a country has a low or high broadband penetration rate. Take for instance Canada, Iceland and some of the other Scandinavian countries such as Sweden, Norway and Finland. All of these countries have lower population densities than the United States, but each is ranked ahead of the United States in broadband penetration.

All of those countries mentioned above have similar urban populations as well indicating that the population centers of the countries are highly localized around the cities and geographical features such as coastal regions. As of 2005, 80.8 percent of the United States' population was considered urban which tied it with South Korea for number 38 on the list of most urban countries in the world ahead of Norway, Finland and Japan. Canada and Sweden ranked slightly higher than the United States in the urban population percentage with 81.1 and 83.4 percent respectively.[87] Adding to the similarities of the countries mentioned above, each has similar GDP per capita as the United States. The defining difference of course is their population size. The United States is the third largest country in the world in terms of population with slightly more the 300 million people. None of the countries that have been mentioned are comparable in population, but this might be an advantage for the telecommunications providers in the

[87] UN Common database (UN Population Division estimates) for 2005.

United States. Larger populations concentrated regionally might increase revenue potential due to the increased number of prospective subscribers located in the same area.

| Rank | Country | Population in 2000 (thousands) | Cumulative percentage |
|---|---|---|---|
| 1 | China | 456 340 | 15.9 |
| 2 | India | 279 045 | 25.7 |
| 3 | United States of America | 218 678 | 33.3 |
| 4 | Brazil | 138 287 | 38.2 |
| 5 | Russian Federation | 106 063 | 41.9 |
| 6 | Japan | 100 089 | 45.4 |
| 7 | Indonesia | 86 943 | 48.4 |
| 8 | Mexico | 73 531 | 51.0 |
| 9 | Germany | 71 798 | 53.5 |
| 10 | United Kingdom | 53 162 | 55.3 |
| 11 | Nigeria | 50 175 | 57.1 |
| 12 | Pakistan | 46 757 | 58.7 |
| 13 | Iran (Islamic Republic of) | 45 023 | 60.3 |
| 14 | France | 44 649 | 61.9 |
| 15 | Philippines | 44 295 | 63.4 |
| 16 | Turkey | 43 844 | 64.9 |
| 17 | Italy | 38 512 | 66.3 |
| 18 | Republic of Korea | 38 269 | 67.6 |
| 19 | Bangladesh | 34 354 | 68.8 |
| 20 | Ukraine | 33 657 | 70.0 |
| 21 | Argentina | 32 662 | 71.1 |
| 22 | Colombia | 31 566 | 72.3 |
| 23 | Spain | 30 974 | 73.3 |
| 24 | Egypt | 28 970 | 74.3 |
| 25 | South Africa | 24 629 | 75.2 |

| Rank | Country | Percentage urban 2000 |
|---|---|---|
| 1 | China | 35.8 |
| 2 | India | 27.7 |
| 3 | United States of America | 77.2 |
| 4 | Brazil | 81.2 |
| 5 | Indonesia | 41.0 |
| 6 | Nigeria | 44.1 |
| 7 | Pakistan | 33.1 |
| 8 | Mexico | 74.4 |
| 9 | Japan | 78.8 |
| 10 | Bangladesh | 25.0 |
| 11 | Russian Federation | 72.9 |
| 12 | Philippines | 58.6 |
| 13 | Iran (Islamic Republic of) | 64.0 |
| 14 | Germany | 87.5 |
| 15 | Turkey | 65.8 |
| 16 | Dem. Rep. of the Congo | 30.3 |
| 17 | United Kingdom | 89.5 |
| 18 | Egypt | 42.7 |
| 19 | Colombia | 75.0 |
| 20 | France | 75.4 |
| 21 | Republic of Korea | 81.9 |
| 22 | Viet Nam | 24.1 |
| 23 | Argentina | 88.2 |
| 24 | Saudi Arabia | 86.2 |
| 25 | Ethiopia | 15.5 |
| 26 | Italy | 66.9 |
| 27 | United Republic of Tanzania | 32.3 |
| 28 | Venezuela | 86.9 |
| 29 | South Africa | 56.9 |
| 30 | Ukraine | 67.9 |
| 31 | Spain | 77.6 |
| 32 | Poland | 62.3 |
| 33 | Netherlands | 89.5 |

| Rank | Country | Population in 2000 (thousands) | Cumulative percentage |
|---|---|---|---|
| 1 | China | 818 793 | 25.6 |
| 2 | India | 729 893 | 48.5 |
| 3 | Indonesia | 125 149 | 52.4 |
| 4 | Bangladesh | 103 085 | 55.6 |
| 5 | Pakistan | 94 499 | 58.6 |
| 6 | United States of America | 64 553 | 60.6 |
| 7 | Nigeria | 63 687 | 62.6 |
| 8 | Viet Nam | 59 321 | 64.4 |
| 9 | Ethiopia | 53 146 | 66.1 |
| 10 | Thailand | 50 352 | 67.7 |
| 11 | Russian Federation | 39 428 | 68.9 |
| 12 | Egypt | 38 914 | 70.1 |
| 13 | Dem. Rep. of the Congo | 35 521 | 71.2 |
| 14 | Myanmar | 34 529 | 72.3 |
| 15 | Brazil | 32 119 | 73.3 |
| 16 | Philippines | 31 358 | 74.3 |
| 17 | Japan | 27 007 | 75.2 |

Table 24. r to l (1) Countries accounting for 75 percent of the world urban population. (2) Level of urbanization for countries with the largest urban. (3) Countries accounting for 75 percent of the world rural population ordered by population size. (From World Urbanization Prospects: The 2001 Revision).

The data contained in Table 24 shows China and India have a greater number of people living in urban areas than the United States does, yet their broadband penetration rates are very low. China is expected to overtake the United States for the most broadband subscribers in 2007. It is inevitable that, due to its vastly higher population,

China will surpass the U.S. in total number of broadband lines, even if the percentage of people in China with broadband lines stays quite small and access is restricted largely to affluent urban areas. In India, home broadband Internet access is not common. The local infrastructure is not built to handle broadband signals yet and the population there does not seem to have a great preference to connect to broadband at home. This has kept the demand low and the motivation low for the telecommunication companies who might invest in new broadband technology. Many people in India connect to the Internet using Internet cafés instead of having a broadband connection at home. Both China and India have the largest number of rural inhabitants in the world. This rural population also plays a role in the amount of broadband penetration. There are only 10 countries that rank in the OECD's top 30 countries in broadband penetration that are also in the top 25 most urban countries in the world. Having large urban populations does not mean the country will have adequate broadband penetration.

The United States has the sixth largest rural population in the world. It also has the third largest urban population. These conflicting demographics partially explain the United States' broadband penetration problem. Broadband penetration is high in the urban areas in large cities and the suburbs surrounding those areas. The problem arises trying to supply broadband access to the rural areas which are spread out and have limited profitability return potential for the telecommunication companies supplying the broadband access. Five of the 11 nations that lead the U.S. in per capita broadband penetration, including Iceland, Finland, Norway, Sweden, and Canada, have significantly lower population densities than the U.S. Population densities can be misleading, though. In all those countries listed, some have a higher percentage of their population living in urban areas and all have significantly smaller populations than the United States does which makes it easier for providing broadband penetration.

Cellular broadband access has not proven to be a great multiplier of broadband users in the United States where a comprehensive, nationwide, third-generation cellular infrastructure is still not a reality. In countries like Japan and South Korea, third generation, 3G for short, is available throughout their entire countries and it can offer adequate broadband connections. The United States' CDMA network that its cell phone networks run off of primarily does not have the same capabilities as the 3G networks

(EV-DO and GSM) available in limited areas of the country and is the primary network for other countries such as Japan and Northern European countries. Broadband through these CDMA networks is slow and often unreliable.

Japan is now on the verge of rolling out a newer cell technology called 4G. This new technology will allow mobile device users the ability to connect to the Internet at broadband speeds by making use of the fiber network and enabling seamless handoff between the two. Users in Japan will be able to access the Internet at any time even while moving at over 100 miles per hour on the popular high-speed trains present there. 4G networks are still a distant promise that some of the cellular networks in the United States have given, and it does not look like it will increase America's broadband penetration problem anytime soon.

Metrics based on per-capita household broadband penetration provide a clearer picture of the broadband problem in the United States. The United States ranked number four in the world for broadband penetration in 2001. It now ranks number 12 in the world according to the latest OECD broadband report which was released in 2006. The ITU ranked the United States number 21 in the world for broadband penetration in 2005. Instead of continuing to progress in broadband penetration, the United States has fallen behind other countries.

# V. BROADBAND POLICY SUGGESTIONS FOR THE UNITED STATES

The goal of any new broadband policy in the United States should be to establish universal broadband access to all residents and businesses at a much higher speeds and lower prices than what is available today. This overarching broadband policy should be cohesive and comprehensive in both its approach and coverage in order to increase competition within the broadband market. At issue is what, if anything should be done at the federal level to ensure that broadband deployment is timely, that industry competes on a "level playing field," that service is provided to all sectors of American society and that broadband prices are kept within a range where the vast majority of Americans are able to afford the services.[88] Governments should continue to encourage wider and more rapid deployment of broadband by reducing, eliminating or avoiding regulation that might increase the cost of entry into or operation of the broadband market. In the end, more people will be connected and the value of the network and its services will increase leading to economic and social improvements for the country. This chapter includes the following suggestions:

- Redefine Broadband
- Increase Federal Spending for Broadband
- Reduce the FCC's Power
- Stimulate Investment Through Tax Incentives and Loans
- Simplify or Eliminate Franchising

## A. REDEFINE BROADBAND

The FCC should redefine the minimum speed requirement for basic broadband. It should also add two additional broadband speed categories. The inadequate 200Kbps rate used to distinguish broadband from narrowband services by the FCC undermines any realistic assessment concerning the actual deployment and adoption of high-speed Internet. The speed and price of a broadband connection may be the most important factor choosing a broadband provider. There should be three different speed categories

[88] CRS Report for Congress, September 8, 2004. p. 19.

used by the FCC: Basic, high-speed and ultra-high-speed. The three levels will give a clearer picture of the speeds service providers offer enhancing the broadband map of America.

| Download Speed | Application | Technology |
|---|---|---|
| 56 kbps | Low Quality, Streamlining Audio | Dial Up |
| 200 kbps | FCC Definition of High Speed | DSL Lite: (256 kbps) |
| 1 mbps | Streaming Video | Satellite, DSL, Cable |
| 2.5 mbps | High Resolution Neurological Testing | DSL, Cable |
| 4 mbps | Standard TV | DSL, Cable |
| 6 mbps | Videoconferencing | DSL, Cable |
| 20 mbps | High Definition TV | ADSL |
| 100 mbps | All | Fiber |

Table 25. Broadband application and speeds (From www.speedmatters.org).

To have some relevance to the speed required by actual applications (e.g., streaming video, videoconferencing, online gaming), the FCC's lower limit for basic broadband should be raised from 200 Kbps to a range of speeds between 1.5 to 3 Mbps. Any provider offering at least 200 Kbps in one direction can consider itself as a provider of broadband service using today's standard. Basic broadband will allow for slower transmissions of large files that are consistent with video, image, and audio files used commonly on many common websites (e.g., YouTube.com, Break.com, and MySpace.com). VoIP should run smoothly and without many QOS problems which occur frequently with slower service speeds. The introductory broadband plans offered by most DSL and cable companies today would fall under the basic broadband description.

The second level will be called high-speed broadband. The high-speed broadband category will include access speeds that range from 10 to 30 Mbps. This range of speeds is fast enough for Internet reception of digital high-definition television and other video uses. These ranges of speed for Internet access are still rare in the United States, but as

newer broadband technology is built or upgraded, these speeds will become more common. This range of speed is offered as premier services by a few DSL and cable companies in the United States as of 2007.

The last level is ultra-high-speed broadband. This category will be for any broadband service that offers speeds in excess of 30 Mbps. This category is used mostly to classify the newer fiber optic broadband networks in the United States like Verizon's new 18 billion dollar FiOS network. Ultra-high-speed category will allow further definition of the United States' broadband map.

## B. INCREASE FEDERAL SPENDING ON BROADBAND

The United States invests relatively less in telecommunications as a percentage of Gross Domestic Product than many other countries ranked ahead of it in the latest OECD poll. The dollar amount per capita that the United States invests in telecommunication (e.g., infrastructure building, research, etc) shows how large the gap is between the other nations. The United States has the largest and most prosperous economy in the world due in part to many factors other than broadband penetration. However, the economic improvement of countries with increased funding for broadband policy has been significant and could have the same affect in the United States. There is a risk to the United States of loosing economic dominance due to its lack broadband penetration.

In 2006, the United States' funding for telecommunications was $21.1 billion while its GDP was a little over $12 trillion. The $21.1 billion was larger than most other nations' telecom investments, but it represented only 0.169 percent of the United States' GDP. The United States should alter its budget so that percentage of GDP used for telecommunication investment grows to at least .26 percent. This will provide an additional $10 billion of investment over what was provided in 2006. It would also make the United States the top ranked country in telecommunication investment at $31 billion per year. The additional $10 billion would be used to fund the 25 "centers of excellence," an overhaul of the research and development (R&D) tax credit and to provide more staffing and program funds for the President's Information Technology Advisory Committee (PITAC).

A powerful government-funded R&D industry can create new broadband technology demonstrations and fund pilot programs in order to promote the rapid acceptance of newer applications which will require broadband access to run. This R&D structure should include 25 state-of-the-art government funded centers-of-excellence where quality telecommunications research can consistently be completed. These centers would be located on the campuses of select universities using existing infrastructure which will limit their fiscal impact. With small staffing requirements (between 10 and 20 people for administrative s), most of the funding for the centers of excellence can be used to recruit and finance quality research projects undertaken by the collaboration of the top leaders in academia, industry and government. Encouraging governmental agencies to back broadband research and promote the use of broadband through funding or propaganda will ultimately increase the likelihood that consumers will show a greater demand for broadband services which might increase supply.

The political process in the United States has a large impact on what telecommunications regulations are enacted. In most of the European regulatory agencies such as the OFCOM, ATR, and RegTP (U.K., France and Germany respectively), the regulatory function is more the function of non-political party regulators where as with the FCC, political affiliations have a significant impact on how the FCC carries out regulations as mandated by the 1934 and 1996 Telecommunications Acts. Sometimes the political determination to enact a well thought out regulation is not strong enough and the regulation falls by the way side. In order to reduce the politics that go into the decisions made by the FCC that specifically affect broadband, Congress along with current presidential administration should push for more influence of and funding for the President's Information Technology Advisory Committee (PITAC). This would supplement the Engineering and Technology Laboratory the FCC funds.

The PITAC is a group of influential private-sector IT leaders along with educational leaders gathered together by the President that could play key roles in increasing broadband performance and penetration in the United States. The Internet and broadband technology are only but a few of the industries the FCC regulates (e.g., radio, broadcast TV and satellite TV). The FCC commissioners must be able to make educated and practical decisions regarding all these different industries. The expertise can

sometimes be lost when trying to find people who want to work for an agency like the FCC because of its overarching responsibilities. The PITAC can provide the specific expertise in broadband technology as well as providing a balanced review of the FCC's rules and policies. Involving the private sector and prominent educators in broadband leadership is essential given the pace of technological advance and today's dynamic business environment.

One of the PITAC's first tasks should be to set out bold long-term goals for the deployment of broadband in the United States, carefully distinguishing the three different levels of service (mentioned in the first section of this chapter). The PITAC also should outline a path that will bring affordable basic broadband ($20 to $25 per month) to 100 percent of the United States' population by 2010. Long-term goals of deploying high-speed and ultra-high-speed broadband should to be worked on as well. The PITAC can recommend to the FCC more efficient regulations that are based in high-technology expertise and they may not be as subjected to interest group pressures. With the added assistance from the PITAC, the FCC's focus could shift to protecting consumer's rights instead of worrying about whether the providers are protected from any monopolistic endeavors. A shift in paradigm will ensure the consumer is looked after instead of whether the provider is being treated fairly.

U.S. industrial R&D expenditures, by source of funds: 1990–2001

| Year | All Industry R&D | Federal funds | Company and other nonfederal funds | All Industry R&D | Federal funds | Company and other nonfederal funds |
|---|---|---|---|---|---|---|
| | Current $millions | | | 2000 constant $millions | | |
| 1990 | 107,404 | 25,802 | 81,602 | 131,638 | 31,624 | 100,015 |
| 1991 | 114,675 | 24,095 | 90,580 | 135,801 | 28,534 | 107,267 |
| 1992 | 116,757 | 22,369 | 94,388 | 135,159 | 25,895 | 109,265 |
| 1993 | 115,435 | 20,844 | 94,591 | 130,612 | 23,585 | 107,028 |
| 1994 | 117,392 | 20,261 | 97,131 | 130,062 | 22,448 | 107,614 |
| 1995 | 129,830 | 21,178 | 108,652 | 140,957 | 22,993 | 117,964 |
| 1996 | 142,371 | 21,356 | 121,015 | 151,696 | 22,755 | 128,941 |
| 1997 | 155,409 | 21,798 | 133,611 | 162,880 | 22,846 | 140,034 |
| 1998 | 167,102 | 22,086 | 145,016 | 173,213 | 22,894 | 150,320 |
| 1999 | 180,672 | 20,496 | 160,176 | 184,608 | 20,942 | 163,665 |
| 2000 | 197,539 | 17,118 | 180,421 | 197,539 | 17,118 | 180,421 |
| 2001 | 198,505 | 16,899 | 181,606 | 193,854 | 16,503 | 177,351 |

NOTES: Constant $ based on calendar year 2000 gross domestic product price deflator. Industrial R&D expenditures exclude federally funded R&D centers administered by industry.

Table 26. U.S. industrial R&D expenditures from 1990-2001 (From Morris, p. 3.)

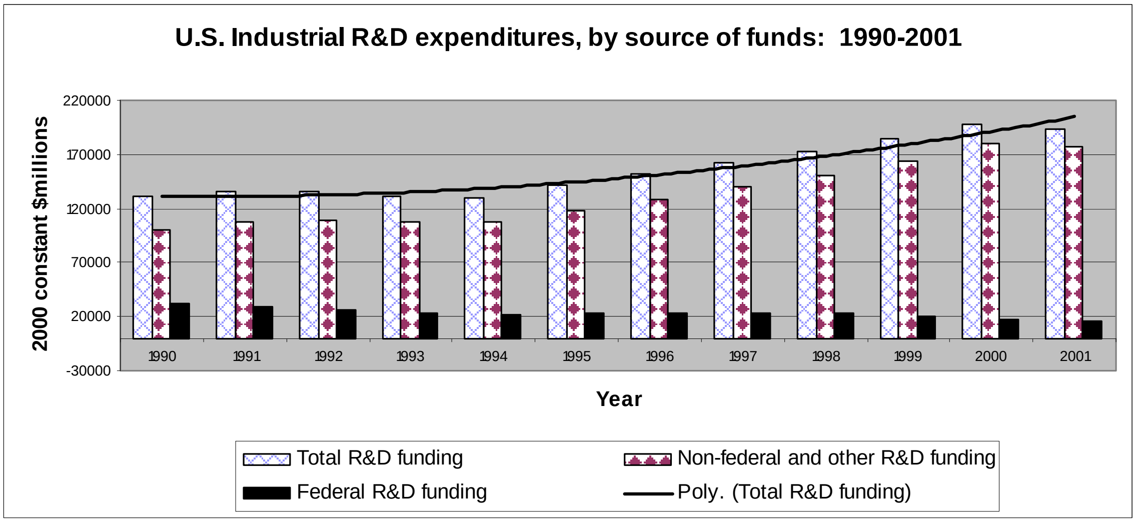


Table 27. Graph of total R&D expenditures in the United States 1990-2001.

In a paper written by Solomon Negash and Lavanya Patala titled, "Telecommunication Investment in Economically Developing Countries," data gathered showed the United States ranked number 78 in the world in 2002 in telecommunication investment based as a percentage of GDP. The United States' closest economic competitor, Japan ($4.5 trillion GDP), spent $22 billion on telecommunication investment in 2006 which equated to .482 percent of its GDP.[89] Shifting money in the budget from the second largest consumer of funds, DOD ($466 billion in 2007), would be very difficult due to the War on Terror. However, there may be ways of shifting some funds from the Department of Education ($89.9 billion in 2007) and the General Government Fund ($20.1 billion in 2007) to the $25 billion budget denoted for science and technology where telecom R&D is funded. Broadband technology benefits both education and it can cut down on costs through e-government initiatives. This shifting of funds is a better alternative to increasing taxes in order to support the additional increase of funding for telecommunications investment.

[89] For comparison, in 2006 the United States spent 3.7 percent of its GDP on DOD ($477.4 billion) and 0.2 percent ($24 billion) on science and technology under which R&D funding is funded. Information gathered from the Federal Budget of the United States 2006. http://www.gpoaccess.gov/usbudget/fy07/browse.html accessed March 19, 2007.

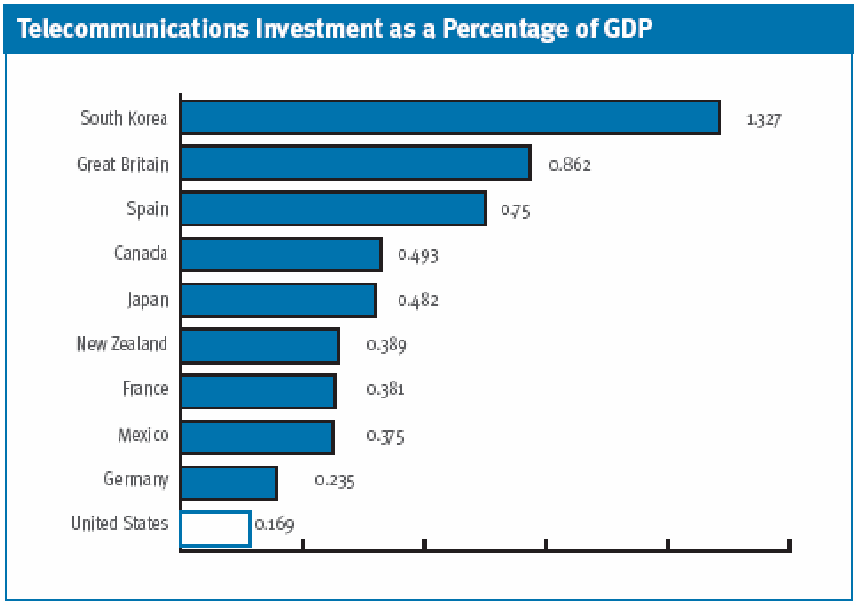


Table 28. Telecommunication investment as a percentage of gross domestic product (From www.speedmatters.org).

Large telecoms in the United States have already invested a great amount of capital into upgrading their networks, particularly Verizon and AT&T with their fiber networks. There have also been a few others like cellular phone companies which have bought up additional wireless spectrum from the government (e.g., T-Mobile, Sprint/Nextel), and some cable companies which are expanding their networks to compete with the large telecom companies. Spending by telecom and cable TV industries in support of broadband networks totaled $12.5 billion in 2005, up 19 percent from 2004.[90] Their investment will benefit America's broadband users, but the positive results may be five to ten years in the future during which time the United States may fall further behind the world leaders in broadband penetration.[91] Verizon meanwhile has seen its net income decline from $1.66 billion in 2005 to $1.03 billion in 2006 as its stock price has fallen (from $43 per share at the end of 2004 to $36 as of March of 2007) and its debt has been downgraded.[92] Its fourth-quarter profits in 2006 fell 38 percent from the previous quarter as costs to build its fiber-optic network have taken a toll on the company's overall health.

[90] Telecommunications Industry Association, www.tiaonline.org/business/media/press_releases/2006/PR06-64.cfm accessed March 15, 2007.

[91] Verizon plans to invest $18 billion from 2005 to 2009 on its new FTTH network while AT&T is investing $4.6 billion in its new FTTN network.

[92] Harrison, p. 1.

## C. REDUCE THE FCC'S POWER

The FCC's power to regulate and set policy was created in 1934. When the 1996 Telecommunications Act was passed by Congress, many parties had hoped that the FCC's multiple and contradictory responsibilities would be limited, but the Act only strengthened the FCC's powers. The FCC now has the power to write the rules which implement the Act, enforce those rules, and adjudicate any disputes that could arise from them. There should be a separation of power at the FCC. Along with separation of powers, the FCC's telecom merger power is excessive and should be eliminated. This adjudication power should be given exclusively to the Department of Justice with the FCC only acting in an advisory role. Separation of powers is something that is practiced all over the world to prevent one entity from having too much power. This is the case for the United States' government as a whole, but when discrete parts of the government are accounted for, the separation of powers sometimes become unclear.

To make the FCC more efficient and exercise less power, there should be another committee (PITAC) or agency that stands in to review and balance the FCC's decisions. Telecommunications and cable TV mergers should not have to be approved by the Department of Justice as well as the FCC. Eliminating the FCC's power to adjudicate the decisions and regulations it makes for a more efficient process which will cost the telecommunications and cable companies less money in litigation and it will also increase incentives for stronger investment in those companies. A statutory structure change of the FCC might result in better telecommunications policy and more efficient regulations.

Independent agencies appointed by Congress such as the FCC have significant oversight and power over the industries they supervise. The President cannot replace the commissioners since they are independent. Congress rarely overrules their decisions while the judicial branch infrequently overturns their regulatory laws. The efficiency and democratic influence within the FCC are diminished because of its lack of separation of powers. The ability of the FCC to write precise rules, administer those rules efficiently and without discrimination, as well as adjudicate those rules is very limited because of the role it plays. The FCC's response time for issues like large telecom mergers or other

regulatory issues has had a significant impact on how broadband has been distributed throughout the United States.

The FCC's lack of oversight from other branches of government has enabled it to write poor telecommunication rules used to enforce the intent of the 1996 Telecommunications Act. Due to the FCC's multiple powers, the rules that have been poorly written are fixed with extra regulation or adjustments in enforcement. This vagueness has led to regulatory uncertainty and sometimes regulatory discrimination. The lack of discipline from any other branch of government on these issues has made the FCC's incentive to write clear and concise rules almost nonexistent. These inefficiencies make for uncertainty among telecommunications companies which then results in less investment and higher costs passed on to the consumers.

## D. STIMULATE INVESTMENT THROUGH TAX INCENTIVES AND LOANS

The federal government should reward broadband investments by new competitors and new entrants as an alternative to promoting the duopolistic approach that is common in many regions of the United States. The government should offer non-dominant companies, organizations critical to public safety and private business owners significant but temporary financial incentives in order to help create new local broadband infrastructure. These incentives might be in the form of low-interest loans, tax breaks or grants to be used in creating broadband infrastructure used for the general public good. These financial benefits may be necessary in order for new entrants to perform well if the local loop is already a natural economic monopoly. Justifying the requirements based on economic or national security would also broaden and accelerate broadband penetration in areas where the dominant carriers are not providing broadband services.

To further stimulate broadband penetration, the federal government should offer tax breaks to all cable and telephone companies planning to increase their broadband network coverage. More infrastructure building by providers will result in lower tax rates which may increase added investment. As more companies offer broadband services, competition increases which will reduce prices and increase performance. At the same time, the federal government should provide guarantees to the telecom and cable

companies that new infrastructure will be protected from the competitor's access for a certain period of time. The initial costs of investing in new infrastructure or services may be offset by the guarantees of being able to use the infrastructure without having to share access with other competitors.

Government at all levels should adopt balanced and innovative tax policies that will bring much relief to taxpayers and at the same time stimulate growth and innovation by broadband providers. Along with tax incentives, the United States should continue to expand its low-interest loan program to help rural and low-income regions build fast and affordable broadband infrastructure of their own. The federal government has a loan program called the Rural Development Community Connect Grant Program that is provided by the United States Department of Agriculture. Requirements for the loans should be simpler and the awarding of the loans should be quicker. Having access to low interest loans may be an incentive to a competing broadband company to enter a market and provide broadband service even when the ILECs and cable companies believe it is too costly.

## E. SIMPLIFY OR ELIMINATE FRANCHISING

The franchising process is prevalent in over 30,000 cities, towns, counties and a few states in the United States.[93] In almost every case, the franchising requirements are different requiring the telecommunications or cable companies to separately negotiate each franchise in every city or town where they provide video services. Unlike other countries, the franchising process in the United States is a highly complex and local process. This becomes an issue when these telecommunications and cable TV companies providing video programming services also provide broadband access over the same network.

[93] McGarty, p. 36.

The FCC or Congress should outlaw the use of franchises since they are monopolistic in nature and prevent competition.[94] A time period of five to seven years should be allowed for existing franchises to expire and after which time no new franchises will be renewed. This will allow enough time for local communities to find alternative methods of funding their governments due to the loss of franchising fees. It will also open up the community to competing video programming providers and lower prices.

If not eliminated, the franchise process should be run by the county or state level instead of at the local municipality. Moving the franchising process from the local government's control to the county or state government's control will provide a more streamlined process in obtaining a franchise. This will cut down on the administrative and legal costs a video programming provider must pay under current franchising rules which are subsequently passed on to its customers. Franchise contracts should be reduced to a mandatory time of two years or less. This will force the franchise to be renewed often and give consumers within the franchise the opportunity for more choices. It will also cut back on the monopolistic market in which the cities force upon its consumers of video programming.

The FCC should define IP video, delivered through fiber optic or high speed DSL connections, as an information service rather than a video service. This will increase broadband penetration in local communities both rural and urban. IP video providers, such as Verizon or AT&T, will be allowed to enter the broadband market in communities without having to obtain a franchise.

Both federal and state governments should pass legislation which limits the effects the franchise time to market has on consumers. The time to market is the amount of time it takes when a competitive cable TV or telecommunications company starts the franchise process to the time consumers actually receive service from that new provider (see Figures 21 and 22). Scaling back the time and administrative requirements which

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[94] To ensure all residents receive the video programming services, cities and towns require complex contracts and a significant amount of fees for legal and administrative requirements paid by the video programming company. The franchise gives the video programming company a complete monopoly on services within the franchise area. They do not have to worry about competitors entering the market providing the same services.

are required to obtain a franchise should be the first step. The average time it takes to obtain a franchise is two years, but it can sometimes take up to 36 months before the franchise is approved and the installation of infrastructure begins.[95] During this time, multiple parties are involved and lots of fees are paid by the company that wants the franchise. This process often eliminates smaller broadband providers wishing to compete in the city or town because of the expensive up-front costs to get anything approved, not considering the capital necessary to install new infrastructure. Competition is almost eliminated right from the start and the incumbent usually maintains its hold on the franchise. Even if the franchise is won by a new competitor, the administrative costs along with the new capital spent on infrastructure must be passed on the customers in order to be profitable.

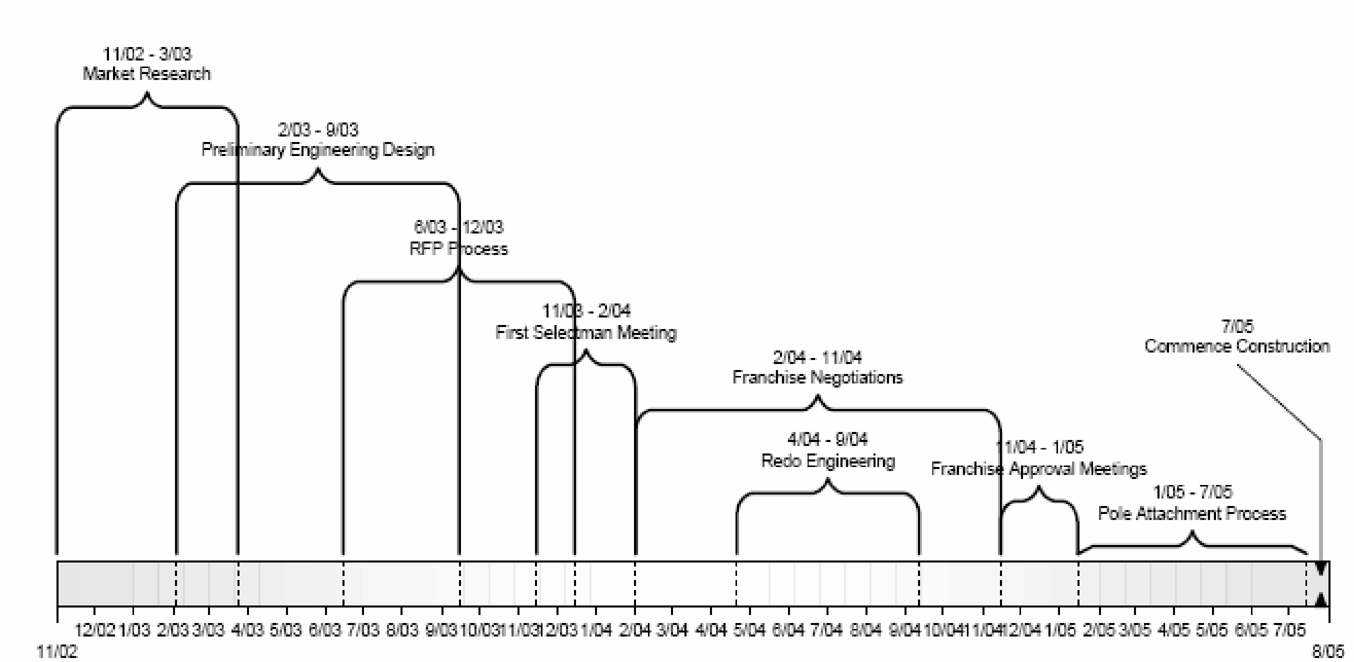


Figure 21. Typical timeline process of a franchise (From McGarty).

[95] McGarty, p. 24-25.

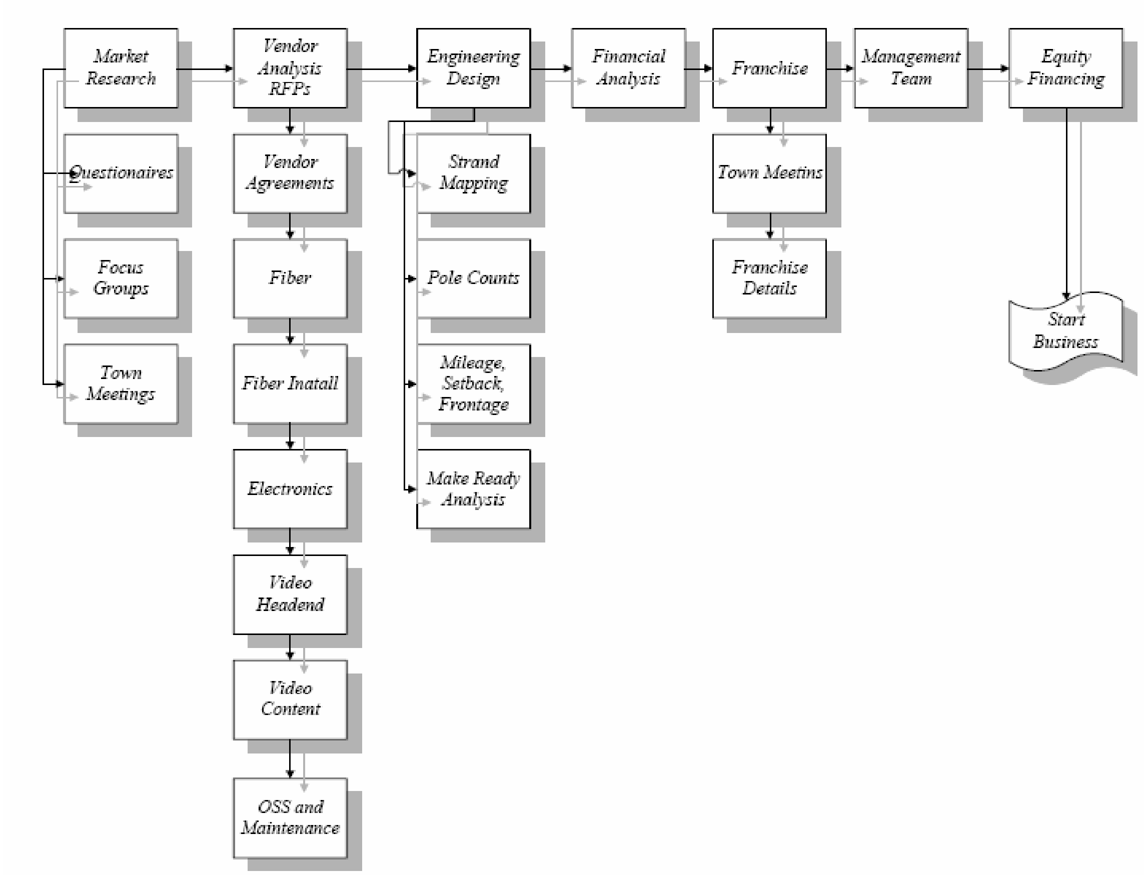


Figure 22. A flow chart of the franchising process (From McGarty).

For the telecommunications industry, the difficulty of applying for a franchise agreement in areas where there already is an incumbent cable TV company is a serious problem. Towns and cities often require new telecommunications companies or cable TV companies applying for a franchise to meet more stringent rules and guarantees than what were expected of the incumbent cable TV company. The city or town already can see what was "won" by other franchising agreements in the area and can demand the same if not more guarantees when renewing its franchise agreement. Incumbent cable TV companies usually do not have to meet these increased demands and often maintain the franchise because the competitors lack of ability or resources to meet the city's demands. In most cases, the market continues to be served by one monopolistic provider and the consumers are the ones left without any choice but the incumbent provider. This process has now prevented competing broadband providers from expanding their services into many local communities that has a franchise already set up with another provider.

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# VI. FUTURE WORK AND CONCLUSION

## A. FUTURE WORK

Most research dealing with broadband technology and broadband penetration is focused more on what regulators and governments should do rather than analyzing what the telecommunications and cable companies are doing and why. To accurately compare and contrast ideas, more research is essential in studying the broadband providers' motives for deploying and upgrading their networks. Independent studies of the broadband companies may provide answers to the United States' low ranking for broadband penetration.

There are a few topics that should be explored further. While the United States' struggles to catch up with other countries in the broadband race, the impact of the overall economy and social welfare should be considered. Although this thesis has brought to light some of the issues which have prevented the United States from becoming a 100 percent connected society, more in-depth research should be done to support a change in broadband policy.

### 1. Further Analysis of Alternative Broadband Delivery Methods

New and improved broadband delivery methods have started to be used in certain areas of the country and the world, such as the use of electric power lines. Costs analysis of newer technologies should be conducted.

### 2. Review of the Telecommunications Act of 1996

An in-depth review of the Act may explain some of the reasons for requiring new telecommunications policy. Reviewing its effectiveness on the telecom and cable TV industries should detail some of the failures as well as some of the successes the Act has created.

### 3. Net Neutrality

Net Neutrality is a topic which may have widespread implications for the content of the Internet. It is a political issue which has sparked much debate in the United States. Referring to other countries like Japan and South Korea, compare their net neutrality rules to the ones being suggested here in the United States.

### 4. Broadband Penetration’s Impact on Military Readiness

As the United States’ military requirements for high technological equipment ranging from complex weapon systems to highly connected networks of communicative resources, the requirements for people with technical backgrounds and higher education will become a potential choke point in maintaining a capable and superior armed forces. Increased broadband penetration could have significant impacts on military readiness because broadband services might be able to increase the quality of military applicants. Future work should be done on the impact broadband has on the quality and quantity of applicants to the United States’ armed forces.

### 5. Security and Protection of Intellectual Property

These will become more important as broadband access expands around the world. The opportunity to use very fast broadband speeds to download movies and other copyrighted material can be used in an illegal way. Content distribution drives the Internet. Discovering new better ways to secure data on a broadband network is more important now than before.

### 6. Analyzing the FCC’s Power

The FCC has a tremendous amount of power. A detailed analysis could determine if this power is excessive and if so, how it could be curbed.

## B. CONCLUSION

Broadband has become a basic public necessity. In the near future, practically all communication will be carried by broadband networks. As the world becomes electronically intertwined and economically connected, the use of broadband applications and services will rise. Those countries that do not meet these requirements will stagnate economically and socially as their neighbors seek to take advantage of increased broadband penetration. The drivers of broadband penetration will come from both government and private initiatives.

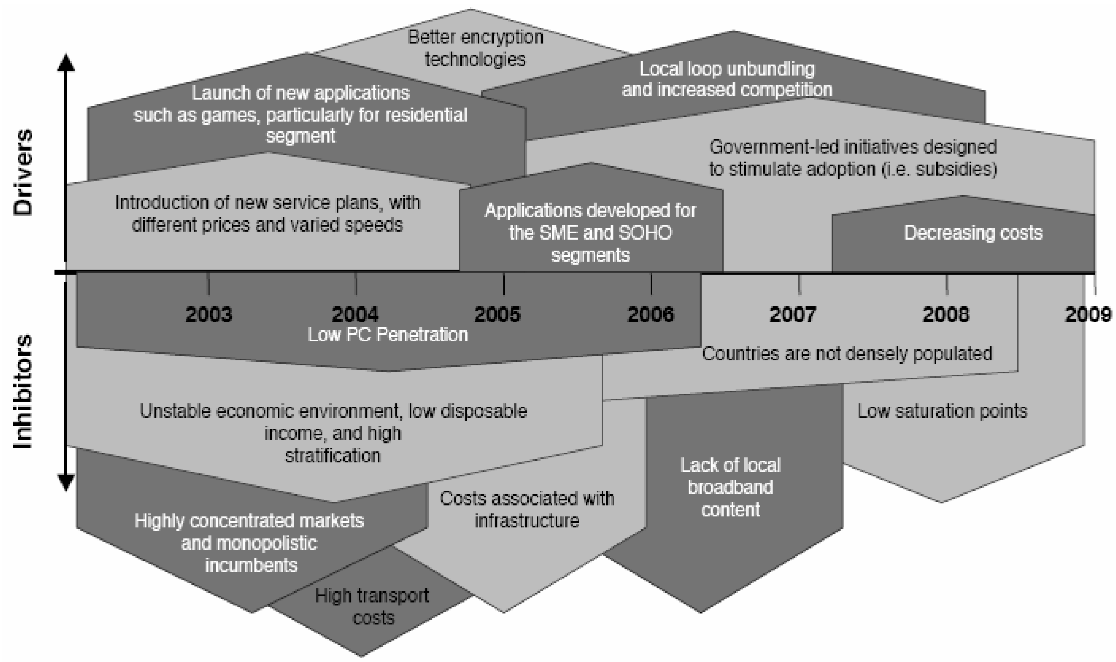


Figure 23. Broadband Drivers and Inhibitors (From Pyramid Research).

The confusing combination of competition and regulation in recent years has resulted in a chaotic and inefficient marketplace, and does not represent the true position of the United States as a technology leader. Broadband policy and regulation must be overhauled in the United States if it is remain the world leader on economic and technology issues.

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# APPENDIX A. 2006 OECD BROADBAND STATISTICS

| | DSL | Cable | Other | Total | Rank | Total Subscribers |
|---|---|---|---|---|---|---|
| Denmark | 17.4 | 9.0 | 2.8 | 29.3 | 1 | 1 590 539 |
| Netherlands | 17.2 | 11.1 | 0.5 | 28.8 | 2 | 4 705 829 |
| Iceland | 26.5 | 0.0 | 0.7 | 27.3 | 3 | 80 672 |
| Korea | 13.2 | 8.8 | 4.5 | 26.4 | 4 | 12 770 911 |
| Switzerland | 16.9 | 9.0 | 0.4 | 26.2 | 5 | 1 945 358 |
| Finland | 21.7 | 3.1 | 0.2 | 25.0 | 6 | 1 309 800 |
| Norway | 20.4 | 3.8 | 0.4 | 24.6 | 7 | 1 137 697 |
| Sweden* | 14.4 | 4.3 | 4.0 | 22.7 | 8 | 2 046 222 |
| Canada | 10.8 | 11.5 | 0.1 | 22.4 | 9 | 7 161 872 |
| United Kingdom | 14.6 | 4.9 | 0.0 | 19.4 | 10 | 11 622 929 |
| Belgium | 11.9 | 7.4 | 0.0 | 19.3 | 11 | 2 025 112 |
| United States | 8.0 | 9.8 | 1.4 | 19.2 | 12 | 56 502 351 |
| Japan | 11.3 | 2.7 | 4.9 | 19.0 | 13 | 24 217 012 |
| Luxembourg | 16.0 | 1.9 | 0.0 | 17.9 | 14 | 81 303 |
| Austria | 11.2 | 6.3 | 0.2 | 17.7 | 15 | 1 460 000 |
| France | 16.7 | 1.0 | 0.0 | 17.7 | 16 | 11 105 000 |
| Australia | 13.9 | 2.9 | 0.6 | 17.4 | 17 | 3 518 100 |
| Germany | 14.7 | 0.3 | 0.1 | 15.1 | 18 | 12 444 600 |
| Spain | 10.5 | 3.1 | 0.1 | 13.6 | 19 | 5 917 082 |
| Italy | 12.6 | 0.0 | 0.6 | 13.2 | 20 | 7 697 249 |
| Portugal | 7.9 | 5.0 | 0.0 | 12.9 | 21 | 1 355 602 |
| New Zealand | 10.7 | 0.5 | 0.6 | 11.7 | 22 | 479 000 |
| Czech Republic** | 3.9 | 2.0 | 3.5 | 9.4 | 23 | 962 000 |
| Ireland | 6.8 | 1.0 | 1.4 | 9.2 | 24 | 372 300 |
| Hungary | 4.8 | 2.9 | 0.1 | 7.8 | 25 | 791 555 |
| Poland | 3.9 | 1.3 | 0.1 | 5.3 | 26 | 2 032 700 |
| Turkey | 2.9 | 0.0 | 0.0 | 3.0 | 27 | 2 128 600 |
| Slovak Republic | 2.2 | 0.5 | 0.2 | 2.9 | 28 | 155 659 |
| Mexico* | 2.1 | 0.7 | 0.0 | 2.8 | 29 | 2 950 988 |
| Greece | 2.7 | 0.0 | 0.0 | 2.7 | 30 | 298 222 |
| **OECD** | **9.7** | **4.6** | **1.2** | **15.5** | | **180 866 265** |

Table 29. Broadband subscribers per 100 inhabitants, by technology, June 2006 (From OECD Broadband Statistics June 2006)

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# APPENDIX B. FIVE YEAR OECD BROADBAND STATISTICS

| | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|
| Australia | 0.9 | 1.8 | 3.5 | 7.7 | 13.8 |
| Austria | 3.6 | 5.6 | 7.6 | 10.1 | 14.1 |
| Belgium | 4.4 | 8.7 | 11.7 | 15.5 | 18.3 |
| Canada | 8.9 | 12.1 | 15.1 | 17.6 | 21.0 |
| Czech Republic | 0.1 | 0.2 | 0.5 | 2.5 | 6.4 |
| Denmark | 4.4 | 8.2 | 13.0 | 19.0 | 25.0 |
| Finland | 1.3 | 5.5 | 9.5 | 14.9 | 22.5 |
| France | 1.0 | 2.8 | 5.9 | 10.5 | 15.2 |
| Germany | 2.3 | 4.1 | 5.6 | 8.4 | 13.0 |
| Greece | 0 | 0 | 0.1 | 0.4 | 1.4 |
| Hungary | 0.3 | 0.6 | 2.0 | 3.6 | 6.3 |
| Iceland | 3.7 | 8.4 | 14.3 | 18.2 | 26.7 |
| Ireland | 0 | 0.3 | 0.8 | 3.3 | 6.7 |
| Italy | 0.7 | 1.7 | 4.1 | 8.1 | 11.9 |
| Japan | 2.2 | 6.1 | 10.7 | 15.0 | 17.6 |
| Korea | 17.2 | 21.8 | 24.2 | 24.8 | 25.4 |
| Luxembourg | 0.3 | 1.5 | 3.5 | 9.8 | 14.9 |
| Mexico | 0.1 | 0.3 | 0.4 | 0.9 | 2.2 |
| Netherlands | 3.8 | 7.0 | 11.8 | 19.0 | 25.3 |
| New Zealand | 0.7 | 1.6 | 2.6 | 4.7 | 8.1 |
| Norway | 1.9 | 4.2 | 8.0 | 14.8 | 21.9 |
| Poland | 0.1 | 0.3 | 0.8 | 2.1 | 2.4 |
| Portugal | 1.0 | 2.5 | 4.8 | 8.2 | 11.5 |
| Slovak Republic | 0 | 0 | 0.3 | 1.0 | 2.5 |
| Spain | 1.2 | 3.0 | 5.4 | 8.1 | 11.7 |
| Sweden | 5.4 | 8.1 | 10.7 | 14.5 | 20.3 |
| Switzerland | 2.0 | 5.6 | 10.1 | 17.5 | 23.1 |
| Turkey | 0 | 0 | 0.3 | 0.7 | 2.1 |
| United Kingdom | 0.6 | 2.3 | 5.4 | 10.5 | 15.9 |
| United States | 4.5 | 6.9 | 9.7 | 12.9 | 16.8 |
| **OECD** | **2.9** | **4.9** | **7.3** | **10.2** | **13.6** |
| **EU15** | **1.6** | **3.4** | **5.9** | **9.7** | **14.2** |

Figure 24. Broadband subscribers per 100 inhabitants, 2001-2005 (From OECD Broadband Statistics June 2006).

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# APPENDIX C. TYPES OF RESIDENTIAL INTERNET SERVICE

| Technology | Description | Avg. Speed | Physical Medium | Comments |
|---|---|---|---|---|
| **Dial-up Access** | Access on demand using a modem and regular telephone line. | 2400 bps to 56 Kbps | Twisted pair (regular phone lines) | • Cheap but slow compared with other technologies.<br>• Speed may degrade due to the amount of line noise (interference). |
| **Integrated Services Digital Network (ISDN)** | Dedicated telephone line and router required. | 64 Kbps to 128 Kbps | Twisted pair | • Not available everywhere but becoming more widespread.<br>• An ISDN line costs slightly more than a regular telephone line, but you get 2 phone lines from it.<br>• 56K ISDN is much faster than a 56K dialup line. |
| **Cable** | Special cable modem and cable line required. | 512 Kbps to 20 Mbps | Coaxial cable; in some cases telephone lines are used for "upstream requests" (to send data from the user's computer.) | • Must have existing cable access in area.<br>• Cost of bringing service into an area and trenching cable can be prohibitive.<br>• Always on.<br>• Up to 50x faster than dial-up<br>• Home broadband prices approx. $40-$50/month.<br>• Limited availability |
| **ADSL/DSL** Asymmetric Digital Subscriber Line (ADSL is the same as DSL) | Uses the unused digital portion of a regular copper telephone line to transmit and receive information. ADSL is asymmetric since it *receives* at 6 to 8 Mbps per second but can only *send* data at 64 Kbps. A special modem and adapter card are required. Bandwidth is affected by the distance from the network hubs. Must be within 3.1 miles of telephone company switch. | 128 Kbps to 8 Mbps | Twisted pair (used as a digital, broadband medium) | • Doesn't interfere with normal telephone use.<br>• Up to 50x faster than dial-up.<br>• Bandwidth is dedicated, not shared like cable.<br>• Always on.<br>• Limited availability.<br>• Home broadband prices are approx. $40-$50/month. |
| **Broadband over** | Uses existing electrical infrastructure to | 500Kbps to | Ordinary power | • Still an emerging |

| | | | | |
|---|---|---|---|---|
| **Power Lines** (BPL) | deliver broadband speeds using BPL "modems." | 3Mbps | lines | technology, not widely available.<br>• Significantly lower deployment costs than comparable technologies like DSL/Cable. |
| **Satellite** | Newer versions have two-way satellite access, removing for phone line.<br>In older versions, the computer sends request for information to an Internet Service Provider via normal phone dial-up communications and data is returned via high speed satellite to rooftop dish, which relays it to the computer via a decoder box. | Usually 400 Kbps downstream & upstream speed. | Airwaves Requires outside antenna to get signal indoors. | • Bandwidth is not shared.<br>• Always on.<br>• Satellite companies can offer integrated TV and Internet service using the same equipment<br>• Some connections require an existing Internet service account.<br>• Setup fees can range from $500-$1000.<br>• Home broadband prices are approx. $60-100/month.<br>• Can be used when DSL & Cable are not available |
| **WiFi** (Wireless Fidelity) | Access is gained by connection to a high speed local area network (LAN) via wireless transmitter/receiver. | 1 to 30 Mbps | Airwaves Requires outside receiver to get signal indoors. | • Can be used for high speed data, broadcast TV and wireless telephone service.<br>• Limited signal range and ability to penetrate building walls; most users will have to buy extra equipment to use service indoors |
| **WiMAX** (Worldwide Interoperability for Microwave Access) | Wireless technology, like WiFi, but handles network traffic more efficiently | Up to 70 Mbps | Airwaves | • Greater signal range than WiFi (up to 31 miles)<br>• Stronger signal can penetrate buildings better for indoor use |
| **Fiber-Optic** | Transmits information as light pulses along a glass or plastic wire or fiber | 1 to 100 Mbps | Optical fiber cables | • Less interference, faster transmission speeds than most technologies<br>• Usually more expensive to deploy |

Table 30. Types of Residential Internet Service (adapted from Hammond and Raphael).

# APPENDIX D. BUSINESS BROADBAND

| Broadband Service | Speed | Prices & Benefits |
|---|---|---|
| DSL | 128 Kbps-1.5 Mbps | 128Kbps to 1.5 Mbps downstream. 64Kbps to 1.5 Mbps upstream. Consumer class is approx. $40-$50/month. Business class is approx. $90-$400/month, depending on bandwidth speed required. |
| Fractional T1 | 128 Kbps-1.0 Mbps | 128 Kbps to 1.0 Mbps T1 speed with some of the 24-64 Kbps channels turned off. Prices are approx. $220-$500/month depending on fractional bandwidth speed required, which includes local loop. Hardware and installation costs vary. |
| T1/DS1 | 1.544 Mbps | 1.544 Mbps digital circuit. Can be dedicated Internet access, point-to-point or integrated (voice & data). Prices are approx. $500-1000/month which includes local loop. Hardware and installation costs vary. |
| Frame Relay | 56Kbps & Up | 56 Kbps & Up. Prices vary greatly depending on bandwidth speeds required. |
| E1 Europe | 2.048 Mbps | European equivalent of the T1. Prices vary depending on service and location. |
| Fractional T3 | 3 Mbps-44.736 Mbps | 3 Mbps to 44.736 Mbps basic T3 with some of the 67-264 Kbps channels turned off. Prices are approx. $3000-$5000/month, depending on fractional bandwidth speed required. |
| T3/DS3 | 44.736 Mbps | 44.736 Mbps digital circuit. Can be dedicated Internet access, point-to-point or integrated. Prices are approx. $5000-15,000/month + local loop + set up costs |
| E3 Europe | 34.368 Mbps | European equivalent of T3. Carries 16 E-1 signals. Prices vary depending on service and location. |
| OC1 | 51.84 Mbps | 51.84 Mbps optical fiber sometimes called SONET. Uses ATM Switches (as do ALL OC-x). Prices are approx. $10,000-20,000/month + local loop + set up costs. |
| OC3 | 155.52 Mbps | 155.52 Mbps optical fiber sometimes called SONET. Uses ATM Switches. Prices are approx. $30,000-50,000/month + local loop + set up costs. |
| OC12 | 622.08 Mbps | 622.08 Mbps optical fiber sometimes called SONET. Uses ATM Switches. Prices are approx. $80,000-100,000/month + local loop + set up costs. |
| OC24 | 1.244 Gbps | 1.244 Gbps optical fiber sometimes called SONET. Uses ATM Switches. Prices over $100,000/month + local loop + set up costs. |

| | | |
|---|---|---|
| OC48 | 2.488 Gbps | 2.488 Gbps optical fiber sometimes called SONET. Uses ATM Switches. Prices into the $100,000's/month + local loop + set up costs. |
| OC192 | 9.6 Gbps | 9.6 Gbps optical fiber sometimes called SONET. Uses ATM Switches. Costs are extremely high. |
| OC255 | 13.21 Gbps | 13.21 Gbps optical fiber sometimes called SONET. Uses ATM Switches. Costs are extremely high. |

Table 31. Business Broadband Speed and Description (From BroadbndBuyer.com).

# APPENDIX E. BROADBAND PENETRATION USING POPULATION DENSITY AND GDP PER CAPITA

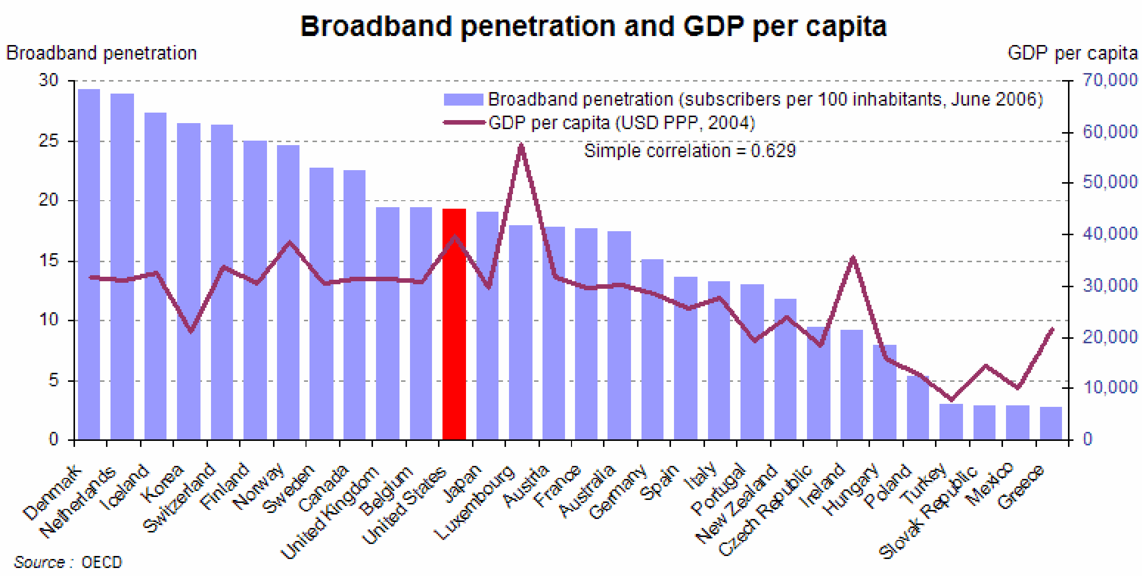


Table 32. Broadband Penetration and GDP per Capita (From OECD and www.websiteoptimization.com).

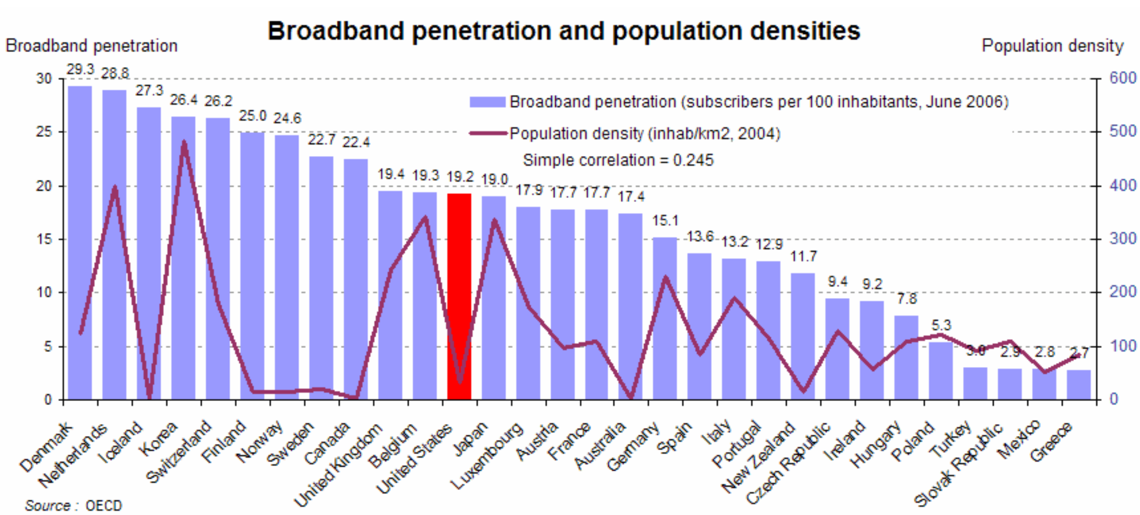


Table 33. Broadband Penetration and Population Densities (From OECD and www.websiteoptimization.com).

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